COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XIX | JANUARY, 1914 | No. 1

SHAFT SINKING UNDER DIFFICULTIES

BY CHAS. A. HIRSCHBERG.

The undeveloped area of the Pocahontas coal field lies at considerable depth under water level, necessitating deep shafts to reach and develop these rich measures.

Extensive development, in this territory, and likewise the deepest shafts were undertaken by the Carter Coal Co., at Coalwood, W. Va., during the present year. This development and all problems and methods for overcoming the various difficulties encountered were worked out and prepared under the direction of William B. Crawford, consulting engineer for the company.

The main or hoist shaft is 16x30 ft., rectangular, timber-lined, having two hoistways and a compartment for stairway, pipes and wires. The depth when completed will be 650 ft. to the Pocahontas No. 4 seam of coal, and the development is planned for a production of 5,000 tons of coal per day. The air shaft is 15x22 ft., rectangular, timber-lined and divided into two compartments, one for air and the other equipped with a geared electric hoist for materials and men.

To hoist the required tonnage from this depth, using single-decked cages, hoisting one 4-ton car per trip, presented an unusually difficult problem. To meet these requirements and conditions, a double conical-drum hoist was designed, coupled directly to a slow-speed, direct-current motor, driven by a motor-generator set having fly-wheel equalizer and Ward-Leonard control. This hoist will be the largest and most efficient of its type, so far installed in the United States, and is now being built by the Westinghouse Electric & Manufacturing Co., at Pittsburgh, Penn.

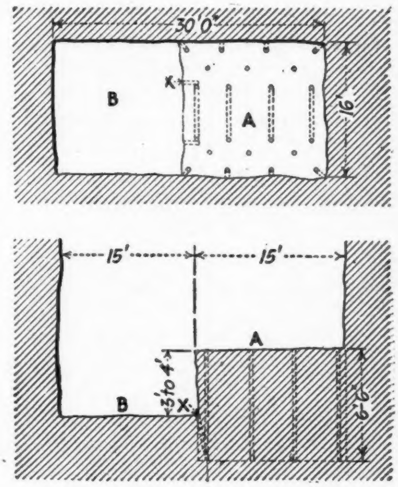


FIG. I. SHOWING ALTERNATE STEPS.

SUCCESS OF SINKING THOUGHT DOUBTFUL.

The success of shaft sinking in this territory has been considered a doubtful proposition, owing to the enormous volume of water to be passed through at various depths, and several companies have abandoned such projects, or carried them through, only at enormous cost. This company while fully realizing the magnitude of the undertaking decided after careful investigation and study that the work could be done in an economical manner, and the various streams of water excluded permanently, as well as during sinking, by forcing cement grout into the fissures and crevices of the water-bearing strata, in advance of the sinking, and thus cementing off the water over a considerable area on all sides of the shafts.

Ransome-Canniff grout mixtures are used

for this work and the grout placed under about 100-lb. air pressure. The grouting holes are drilled with a Sergeant 3¼-in. rock drill. The results obtained have been highly satisfactory, making the work of sinking reasonably dry. This company also proposes, at its second pair of shafts which are to be started in the near future, to shut off all water by grouting, before actual sinking is begun, thus making the work dry and rendering much greater speed possible when the shaft is sunk.

After the work of sinking had progressed some 200 ft., it was decided that the ordinary type of air drills mounted on shaft bars and tripods, was neither giving the best results nor making the progress desired, The space required to operate these drills interfered seriously with continuous mucking, and the delays necessary in lowering and hoisting equipment, setting columns and mounting drills were considerable, and seriously affected the average sinking speed.

After several experiments, six Jackhamer drills, of the self-rotating type, made by the Ingersoll-Rand Co., were installed and a different method of drilling and shooting was adopted. With these drills and system, each shift is required to drill, shoot and muck out, giving an average gain of 3 to 4 ft. per day in each shaft. This is considered good progress, taking into account the adverse character of the formation, and the delays on account of grouting and water, and has more than doubled the speed of the old system using the other type of drill.

The method of working and drilling is shown in the accompanying sketch, Fig. 1. The shaft is divided into two sections *A* and *B*, each being drilled and shot alternately, so that each section in turn becomes the "bench" and the other the "sump." This method of sinking permits drilling and mucking operations to be carried on simultaneously by restricting the muck to alternate sides of the shaft. This sump is kept clear of water by means of two Cameron sinking pumps.

THE ARRANGEMENT OF HOLES.

The sketch also shows the position of the various holes. The round averages 24 holes, 6½ ft. deep for each section, 8 being drilled for cut holes and 14 for squaring, while the two marked *X* are drilled last and fired with the squaring holes to act as lifters.

The average drilling time for the round, using the Jackhamers, has been reduced to from 3½ to 4 hours. The steels advance in 1-ft. changes from 2 to 8 ft., with bit sizes as follows:

No. 1—2-ft. steel, 2¼-in. six point, or rose bit.
No. 2—3-ft. steel, 2⅛-in. six point, or rose bit.
No. 3—4-ft. steel, 2-in. cross bit.
No. 4—5-ft. steel, 1⅞-in. cross bit.
No. 5—6-ft. steel, 1¾-in. cross bit.
No. 6—7-ft. steel, 1⅝-in. cross bit.
No. 7—8-ft, steel, 1½-in. cross bit.

This gives a gage variation of ⅛ in. and the steel being ⅞ in. hollow hexagonal, provides ample clearance for the cuttings to be expelled.

This is greatly aided by the hole-cleaning device, or throttle, placed on the exhaust *A*, see Fig. 2. The operator closes the throttle, forcing the air down through the hollow steel to the bottom of the drill hole, and assists the cleaning action and loosens up the cuttings by churning his machine up and down in the

FIG. 2. JACKHAMER DRILL.

hole, the bit being held in place meanwhile by a special device. *B*.

The sinking equipment, consisting of one "Imperial" duplex and one "Sergeant AA-2" straight-line compressor, hoists, two Cameron pumps, drill sharpeners and shop tools, is all operated electrically, current being supplied by the Appalachian Power Co. from one of its numerous substations. A pressure of 100 lb. is maintained at the drills, and the explosive used is 1-in., 60 per cent. gelatin, fired with electric batteries. I am indebted to Mr. Crawford, also to J. J. Renehan, superintendent of sinking, and George E. Kerivan, for much of the foregoing information.—*Coal Age.*

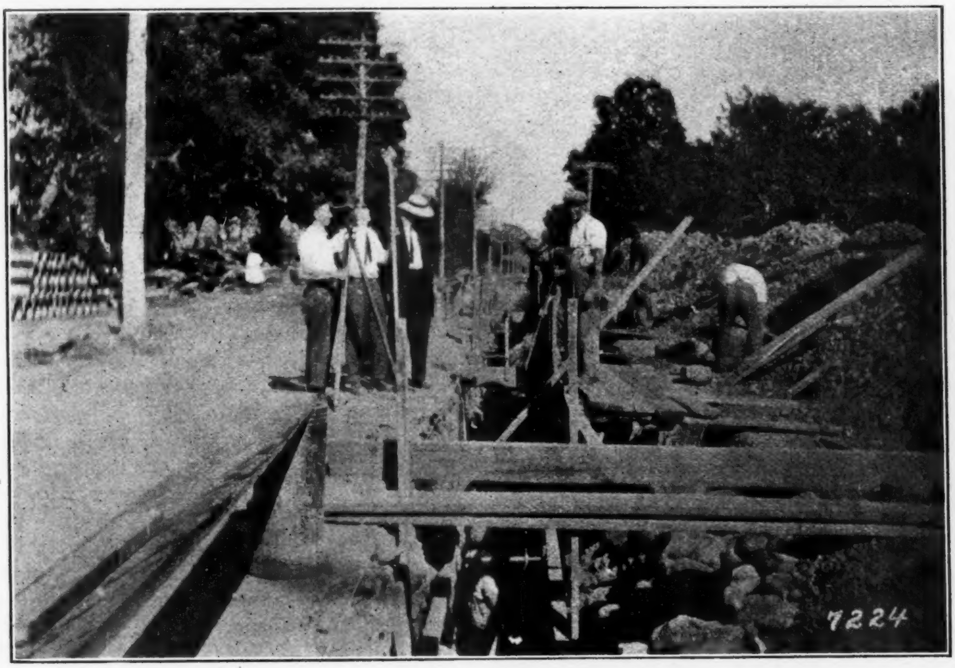


FIG. I. SINKING A DEEP TRENCH.

CUTTING A SEWER TRENCH THROUGH WITH STEAM-OPERATED HAMMER DRILL

BY CHARLES C. PHELPS.

The operating of hammer drills by steam is not very common practice, compressed air being more often used for this purpose. On certain jobs, however, steam may be decidedly more convenient; for instance, when a steam plant is already available and the size of the job does not warrant additional expenditure for an air compressing plant. In such cases there is no good reason why steam should not be employed, provided the drill is adapted to its use.

An interesting job of this sort is being carried on at New Britain, Conn. This city recently undertook to extend one of the sewers on the outskirts of the town for a distance of nearly 700 feet. The work is being done by city employes, and is in charge of Mr. John E. Moore, President of the New Britain Board of Public Works, to whom we are indebted for the data contained herein.

This sewer is for sanitary drainage and is made of 10 inch tile piping. The trench that is being excavated is 15 feet deep and about 42 inches in width. It is located at the side of the road and parallels a storm sewer that is very close to the trench, but much nearer the surface. The proximity of the storm sewer made it necessary to exercise considerable care in cutting, shoring and blasting, so as not to disturb the older sewer. Figure 1 gives a good general idea of the trench and its surroundings. The old storm sewer is directly under the pile of excavated earth. The cut is principally in earth for the first five feet and

FIG. 3. THE POWER PLANT.

in trap rock for the lower ten feet. The rock varies greatly in hardness, increasing the difficulty of drilling. Some of the rock encountered is extremely hard, and some is soft, oxidized trap.

About 525 feet of trench had been cut on the date when the accompanying photographs were taken, August 11th, 1913, leaving about 160 feet of trench still to be excavated.

Two Jackhamers are employed, their two operators accomplishing a much greater amount of work than the six drillers who had formerly carried on this work by hand methods. The drills are operated by steam at a pressure of nearly 80 pounds per square inch. Practically the only difference between these drills and Jackhamers for air operation is in the piston, which is very slightly smaller in diameter in the steam drill to allow for expansion when the machine heats up. The drill handle being of wood, remains cool. A short pipe screwed into the drill outlet conducts the exhaust steam away from the operator, so that it is a very comfortable job to operate one of these drills even in warm weather. One particularly important feature of the Jackhamer is the automatic rotating device, by means of which the steel is rotated in the drill chuck thus making it unnecessary to oscillate the drill by hand. The great advantage of this feature for trench work, where quarters are often cramped, will be at once apparent. When operated by air, a hollow steel is used with the Jackhamer. By means of a hole-cleaning device attached to the Jackhamer, the air can be sent down into the hole at the will of the operator, effectively cleaning it of cuttings. A steel retainer also adds to the ease of manipulating the machine, as the steel and drill can be churned up and down in the hole while blowing out the cuttings, thus hastening the operation. With steam operation, however, the hole-cleaning arrangement did not prove to be very satisfactory in this rock, so the hole is kept full of water poured in from a pail. The cuttings are scooped by means of a tree branch having a smashed end. The branch is driven into the hole and withdrawn quickly, this pump-like action forcing the water and cuttings out of the hole in a satisfactory manner.

The sides of the five foot earth cut are shored up with planking. The first cut made

in the rock is about 4 feet deep to get below the level of the adjoining sewer. The remaining six feet is bored in two cuts of 3 feet each. The spacing of the holes averages about 2½ feet both lengthwise and crosswise.

Three changes of steel are used per cut. The starting bit is 2 in. diameter, the second is 1¾ in. and the bottoming bit is 1½ in. After drilling a hole to bottom, a wooden plug is inserted in it to keep out dirt, etc.

A six-point bit is employed for drilling the softer rock, but in the harder rock a cross bit is used.

Four sticks of 60 per cent. dynamite are used per hole. At the beginning of the work 40 per cent. dynamite was used, but it proved not to have sufficient strength for this kind of rock.

The number of laborers on this work has varied at different stages of the work. The foreman has general charge and looks after the boiler as well. There are two drill runners. The force of muckers who remove the spoil with pick and shovel and replace it, has consisted at various times of from 15 to 40 men. At the time the pictures were taken there were 26 on the job.

There is one nine-hour shift per day, excepting on Saturdays, when the shift is of 5 hours' duration. The rates of wages are as follows:

Drill runners	$2.50 per day
Laborers	2.00 per day
Blacksmith	2.25 per day

The speed of drilling has varied greatly owing to the varying hardness of the rock. Sometimes the performance of the two drills has run as high as 80 feet per 9-hour shift, and sometimes it has run as low as 50 feet, but the average drilling performance has been 60 feet of hole per day, or more, which is equivalent to about 7 feet of hole per hour in trap rock of average hardness. The very poorest record for a single day's work with one drill has been 10 feet of hole. Taking the average figure of 30 feet per day per drill, the labor cost of drilling would be 8⅓ cents per foot of hole.

The blacksmith and his helper devote about seven hours of the nine sharpening the steels. For both drills not more than 8 inches of steel broke off and caused trouble during three months of work.

The power plant for this job consists of a portable Ames steam boiler carrying about 80 lbs. pressure. The water is fed to it by an injector, the water consumption averaging about 192 gallons per day. During the first eleven weeks of constant operation about 4½ tons of soft coal were consumed.

Leading from the boiler is a one-inch iron pipe which crosses the road and connects with several lengths of pipe of the same diameter, laid along the ground beside the trench. This pipe has tees at convenient distances for connecting the drill feeds. When it becomes necessary, with the advance of the work, to move the boiler along, the back lengths of pipe are unscrewed and connected to the front. The drill feeds are ¾ inch rubber steam hose.

Figure 2 shows one of the drill runners at work on the bottom cut of the trench.

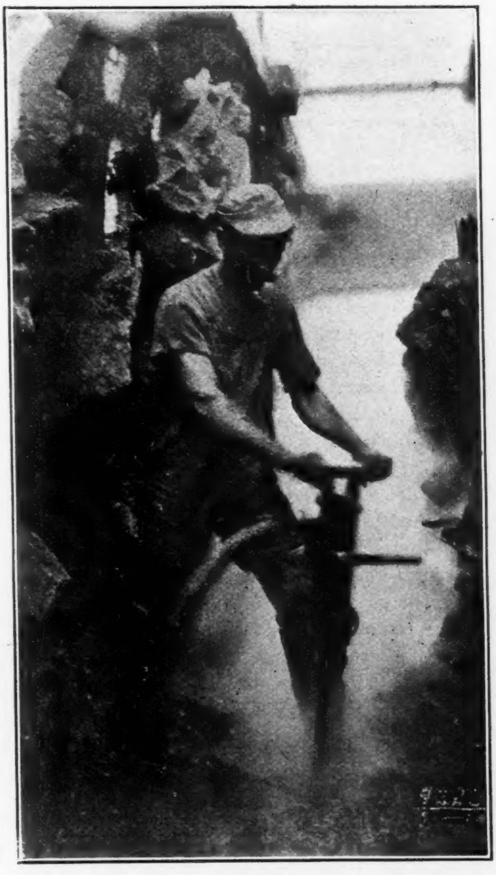
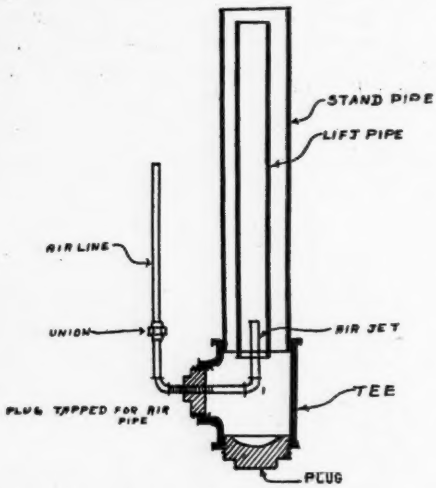


FIG. 2.

AIR LIFT FOR ELEVATING PULP IN CYANIDE PLANTS

BY R. H. SHAW.

The following sketch is a suggestion for the construction of airlifts for ues in elevating pulp in cyanide plants. This design has been used at the Colburn-Ajax mill for some time past, and has proved very satisfactory in every way.



In raising pulp by means of airlifts, one encounters the problems of broken compressors, chips of wood, pieces of belt, and numerous other things, which, with almost human maliciousness, find their way into the pipes. These cause chokes which are difficult to loosen and may cause serious delay. The design given is made with the object of accessibility and rapidity in removing chokes.

In case of a choke, the plug on the bottom of the tee is removed. This drains the standpipe and lift-pipe, and usually cleans out everything except the air line. Next the union on the air line is disconnected and the other plug, together with the horizontal nipple, is removed from the tee. The horizontal nipple is screwed into the elbow (marked 1) loosely, so that it readily comes apart at that point while the plug is being unscrewed. All the pipes now can readily be cleaned of sand or slime.

To replace the parts the vertical nipple and elbow (marked 1) must be held in place through the bottom of the tee and the air pipe screwed in at the same time as the plug in the side of the tee is replaced. The bottom plug is then put back into place and the lift is again ready to operate. The maximum time usually required for this complete operation is about 10 minutes. The loss of pulps and solution is negligible compared to the time saved.

This construction requires the lift to be at least one foot above the floor and supported from clamps around the pipe. Ordinarily, both of these details are readily accomplished.

LAPLAND IRON MINES

One of the most important iron mines in the world is the Loussavaara-Kürunavaara, situated at Kiruna, Lapland, in latitude 68½ degrees north, which is about the same as the northernmost boundary of Alaska. The climate is somewhat milder than in Alaska, and these mines are worked the year around. About 1,600 men are employed and the equipment is all of the most modern machinery obtainable. Machine tools for the repair shop, air-compressors, and rock-drills, and several of the largest steam and electric shovels are of American make. The plant is operated by steam power, the coal coming from England and Spitzbergen. The electrification of the mines is in progress, and this power will be used exclusively as soon as the new power-plant of the state of Sweden, now under construction at Porjus falls, is completed. The capacity of this station will be 150,000 hp. to be transmitted at 78,000 volts over a distance of 150 miles. The ore is shipped from Kiruna to Narvik on the Norwegian coast by rail, and from there by water to Germany, a small percentage finding its way to other countries. The equipment is being rapidly increased and will soon be sufficient to ship more than 10,000,000 tons per annum. Up to the present time about 25,000,000 tons of ore has been shipped. The ore is magnetite and contains from 53 to 68½ per cent. iron. Owing to the comparatively large content of phosphorus it was impossible to utilize it until the Thomas furnace was developed.—*Daily Counsular Report.*

According to the English coal mines act a place shall not be deemed in a fit state for working if the air contains less than 19 per cent. oxygen or more than one and one-quarter per cent. carbon dioxide. The percentage of inflammable gas must not exceed 0.25 per cent. in an intake air-way.

ARRANGEMENT AND CONSTRUCTION OF FACTORIES*

BY W. L. SAUNDERS.

Having selected a site, the next question of greatest importance is the laying out and construction of the buildings. Each line of product calls for such an arrangement as would best facilitate the handling of it. In textile work, for instance, buildings arranged in blocks, many stories high, are economically correct, while in the heavy machinery line a ground floor shop is best.

SAW-TOOTH ROOF CONSTRUCTION.

The saw-tooth construction still holds supremacy for works built all on one floor. This saw-tooth construction comprises a series of gables arranged like the teeth of a saw, the glass in the gable facing the north, and thus giving plenty of light without sun. This construction is in the main a series of steel or iron posts spanned by trusses and so arranged that extension in any direction is easily effected. The cost of a saw-tooth building is low when compared with any other type of building. Complete with cement flooring and roof it is about one dollar per square foot.

The saw-tooth building has the disadvantage of not affording means for transportation of material by overhead cranes, so that it is used mainly where the product is light enough to be transferred by trucks.

MULTIPLE STORY CONCRETE.

The multiple story concrete building is a modern design, which in some cases replaces the saw-tooth construction. This multiple story building is practically cast over steel frames. The entire surface area of each floor above a point some four or five feet from the floor line is glass, and all the rest of it, including floors and ceilings, is concrete or brick. This building is a monument, indestructible by fire, with plenty of light, and its cost per square foot of floor area is less even than that of the saw-tooth construction. Such a building is suitable for light manufacture where the product comprises certain things which are made wholly or in part on each floor. Freight elevators are provided for transporting the material from one floor to the other. This construction, of course, occupies less space than the saw-tooth type, and the only prominent disadvantage is that if it becomes desirable to increase the space for turning out the product of one floor only, other than the ground floor, it will be necessary to extend all of the floors simultaneously.

FIRE PROTECTION.

Whatever the type of building adopted most earnest consideration should be given to the question of fire protection. The day of wooden shops is over, because of the burden of insurance and the danger arising from a possible paralysis in business. Fire rates are nowadays brought down to a negligible figure by proeprly designing the works. It was originally supposed that buildings should be detached one from the other so as to prevent the possibility of total loss, but with the modern steel and concrete structure this is not necessary. Even the sprinkler system, which became general in works a few years ago, is becoming obsolete and unnecessary in buildings of reinforced concrete which are practically indestructible.

In pattern shops and in places where there is inflammable material in storage or in process of manufacture, even though the building be absolutely fire proof, it is best to provide sprinklers, because should a fire occur, the sprinklers confine the flames to a limited section, and thus save property and perhaps life, but in general machinery manufacture sprinklers are unnecessary, where the buildings are properly constructed.

TYPE OF ORGANIZATION.

Organization is of paramount importance in all manufacturing. Success or failure depends upon organization, and first in importance is the manager. Only a day or two ago I received through the mail a little circular from a Corps of Efficiency Engineers, which attracted me because of the head-line, "The Needs of the Successful Manager." This circular goes on to state that "the chief necessity of the successful factory manager is knowledge." It then enumerates eleven points of importance, which, according to this circular, qualify the successful manager.

The first point is—tnat he must know that his Purchasing Department is being operated on an efficient basis. It then goes on to specify that his knowledge must extend to the question of waste in each department, he must know

*Abstract from address before the Graduate School of Business Administration, Harvard University, Sept. 26, 1913.

the cost elements, the productive capacity of the works, the assets and liabilities of the company, and finally "he must know that his Sales Department is being handled in the best possible way."

From the standpoint of Efficiency Engineers seeking business this may be all well and good; but these specifications do not correctly characterize the successful manager. The first and the governing consideration is the handling of men. This is the hall mark of the successful manager; all else is secondary in importance. The manager who knows how to handle men knows how to organize the works for the best results. He is the court of last resort, he must be the one to say "Yes" or "No" in the works, and without such a man success in manufacturing is always jeopardized.

The successful manager provides a superintendent under him who handles the foreman of each department, or in some large works the manager provides a superintendent for each department, each superintendent reporting to him and the foreman reporting to the superintendents. The extent or size of the works governs details of this kind, but the qualities that make for success in a manager are executive ability and a capacity to inspire confidence in his organization. He must be in touch with his official family, that official family meaning all the superintendents, heads of departments and clerks, even in some cases going down to the office boys. He need not be in touch with the man at the lathe, the mechanic or the workman, but he should know his boss.

Regular meetings for assimilation of ideas betweeen the manager and his official family will mean the efficiency and success of the organization. I have known of cases where two or three superintendents of different departments, all of them good men, yet jealous of each other, disliking each other, not associating with each other at home, were brought to a condition of friendship and cooperation by meeting daily at lunch with the manager and sitting at the same table with him.

I cannot agree that the successful manager must know that his Sales Department is being handled properly. The less he has to do with this the better. In fact I have never seen any advantage derived from having the Sales Department or the Executive Force of a company located directly at the works. The manager's business is to turn out the product expeditiously and efficiently. If his time is occupied in daily reporting to the President or other officials of the organization, discussing questions with them, he cannot be directing the works. His best work is done where he is isolated, reporting personally weekly or monthly to the Sales Organization, but being all the time on his job and knowing that he has the confidence of the officials and of the men.

Human nature is a governing force among working men. If they are treated well and have confidence in their boss they will do their best work. The inspiration of confidence must come from the manager, his character is stamped upon the entire organiaztion.

ATMOSPHERIC INDUSTRIES IN NORWAY

An English company, the Northwestern Cynamide Company, has built large works at Odda, on the Hardanger Fjord, and established, on a successful basis, the manufacture from atmospheric nitrogen of calcium cyanamide, which is competing with Norwegian calcium nitrate for recognition as the most economic form in which the air can furnish nitrogenous compounds for the needs of agriculture. The firm shipped 752 metric tons in 1909 and 4,281 tons in 1910. The price is $42.88 per metric ton. The industry is evidently on a firm footing and finds a market for its products, as do similar works in Germany.

At Notodden, in 1905, the first factory for manufacturing nitric acid directly from the elementary gases of the atmosphere was erected. In an enlarged form it now gives occupation to 500 workmen and is daily demonstrating the remarkable possibilities of this new factor in chemical industry, and in economic evolution. The factory furnishes constantly increasing quantities to foreign countries. The exports for two years were as follows: 1909—calcium nitrate, 9,422 tons; sodium nitrate, 3,200 tons; sodium nitrate, 1,074 tons.

THE WEBER SUBURBAN PUMP

The Weber suburban pump here illustrated is designed especially for suburban service. It is operated by compressed air and can therefore be located at any distance from the operating machinery. The power plant consists of an air compressor, an electric motor, or gasoline engine, and an air receiver. A special pump house near the well or spring is not required. The compressor and motor can be placed in the basement of the main house, in the garage or in any other outbuilding to protect them from the weather. One air pipe and one water delivery pipe, both placed below the frost line, connect the pump with the power and service ends. The operation may be entirely automatic, outside of an occasional oiling and cleaning. The water remains in the ground, its natural reservoir, until needed for use.

This pump differs, therefore, from the so-called water storage or pressure tank system in two main points: (a) *Convenience in attendance;* it is not necessary to leave the house to start the pump; (b) *Quality and freshness* of the drinking supply; by opening a faucet pure water at ground temperature and *uniform* pressure is available.

OPERATING DETAILS.

The pump is of the direct displacement type. Water enters the inlet valve at the bottom of the pump chamber when the chamber is submerged. Air pressure is applied directly to the upper surface of the water and forces it through the discharge pipe direct to the plumbing service, so that a constant supply of cool and fresh water is available at every faucet. Admission of air from the air receiver is controlled by means of a combined regulating and reducing valve, also a reversing valve, as shown in the piping diagram, Fig. 3. The reducing valve is under control of the house water pressure and shuts off the air supply to the reversing valve and pump chamber when the house service line is fully charged. The withdrawal of a cup of water is sufficient to admit a supply of air to the pump chamber to replace the water withdrawn, as the reducing valve is sensitive enough to open wide with only ¼ pound change in pressure.

The pump will deliver water as long as the air receiver gauge indicates a pound above

FIG. I. WEBER SUBURBAN PUMP.

For Open or Dug Wells, Lake, Cistern, or Springs.

the required working pressure. With an automatic starting device the compressor is then started and when the air storage tank is

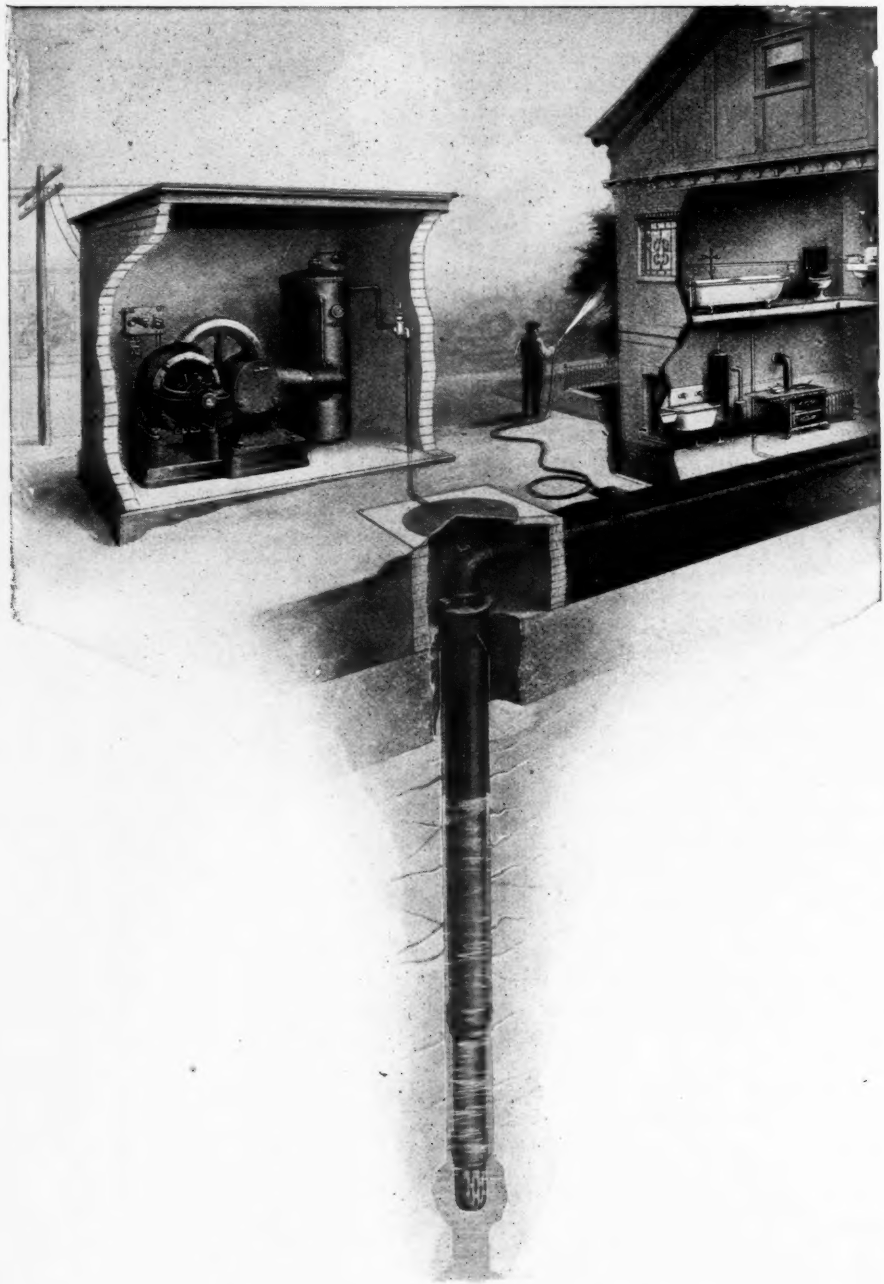
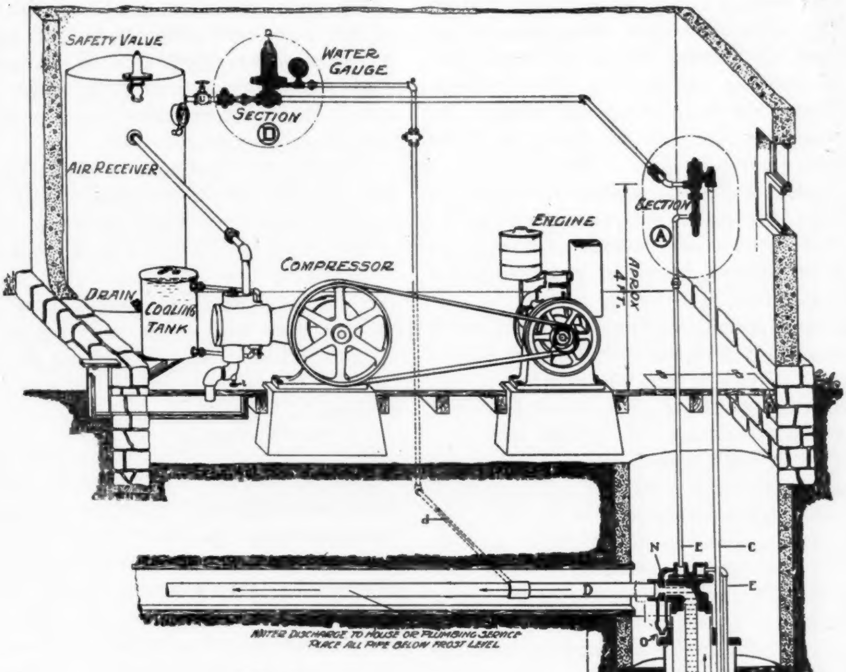


FIG. 2.

charged to about 100 lbs. pressure the current is automatically cut off and the compressor remains idle until the air supply has been used.

When the power plant is equipped with an electric stopping and starting device, the air receiver may be of smaller size than with a gasoline engine power plant, for the electric



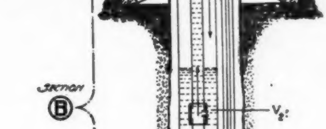


FIG. 3.

device automatically charges the receiver, but in the gasoline engine plant it is necessary to stop and start by hand, and therefore the time interval is usually made as long as possible by increasing the size of the receiver. The usual time required for storage is a continual operation of the compressor for one hour, and it is therefore possible in an average installation to have a three days' supply of water for one hour's actual operation of the plant. When it is considered that the water in this case is not stored in slimy pressure tanks, where it is stagnant and unsanitary, but comes directly from the ground, fresh and pure, the advantage of this type of pump is manifest.

A COMPLETE INSTALLATION.

A complete installation is shown in the illustration, Fig. 2, and consists of an air compressor, an electric motor (or gasoline engine), an air receiver, and a complete set of pump fittings with necessary valves.

An electrically operated plant, when equipped with an automatic pressure regulator pan-

el, under control of the air receiver pressure, possesses advantages over other types of installations on account of the automatic feature of stopping and starting. The only attention required is an occasional oiling. The air compressor may also be driven by steam or from a counter-shaft. The air receiver is usually charged to pressures up to 100 or 125 pounds per square inch, and may be of the horizontal or vertical pattern. It may be placed according to convenience, in the power house or outside.

The pump is made in four stock sizes, ranging from 120 gallons per hour to 1,500 gallons per hour. The open well type is made of galvanized iron and fitted with water valves of standard pump design. The deep well type is made for wells from 4" in diameter upward, and the design permits of pumping from any depth or pumping water level. The deep well type is constructed of common pipe and special bronze fittings, shown in sectional diagram, Fig. 3. Fig. 1 shows the arrangement for open or dug wells, lake, river, etc., the range of lifts and pressures being the same as in other cases.

VENTILATING AND COOLING IN TUNNEL DRIVING*

A great gap has been filled in the field of ventilation since the driving of the Mont Cenis tunnel, where the only air available was obtained from the exhaust of the rock drills. The miners' anemia was high and the driving progress was very slow. As a matter of fact, it would have been impossible to consume much explosive or to have many shifts working in the tunnel at the same time.

The same conditions prevailed when driving the St. Gothard tunnel, where only 70 sec. ft. of air was made available for ventilating purposes. The miners' anemia was intense; on the south side of the tunnel as many as 60 per cent. of the men were more or less affected. During bad periods men would quit work after two months, although working only two out of three days, with five working hours only per day.

*Portion of an article by E. Lauchli, Civil and Hydraulic Engineer, New York, in *Engineering Record,* Nov. 8, 1913.

The poor ventilation, combined with the relatively high rock temperature, and the rudimentary sanitary conditions were a great hindrance to progress, and it is stated, for instance, that the contractors lost as many as 20 horses per month.

The sanitary conditions at the Arlberg tunnel, together with the introduction of a ventilating system capable of delivering from 100 to 200 cu. ft. of air per second, were a great help toward good progress. It is true that the overlying mass was small, thus causing the maximum rock temperature not to exceed 65 deg. Fahr., but the use of Brand water drills made it impossible to use the exhaust for ventilation.

COOLING THE AIR.

When in 1891 the Simplon project was taken up the maximum rock temperature expected to be encountered was 108 deg. Fahr. A very substantial system of ventilation was recommended by the commission of engineers charged to report on the feasibility of this project, and after the impracticability of using ventilating pipes for such an undertaking had been demonstrated theoretically, twin tunnels were recommended. The consistency of the results of this computation with practice was only too well proved when, during the driving period of this tunnel, the rock temperature rose to 132 deg. Fahr. and necessitated an elaborate refrigerating system in addition to the ventilating plant of some 1200 sec. ft. capacity.

One cannot realize the meaning of an accidental shut down of the ventilating plant in an undertaking of this kind. Imagine hundreds of men working some 30,000 ft. away from the portal, in an atmosphere saturated with humidity, vitiated by gases due to the consumption of hundreds of pounds of explosives, and in a temperature of 130 deg. Fhr.

The limit of efficiency of cooling the air in a deep tunnel by introducing air from outside is rapidly reached, especially during the summer months. In the Simplon tunnel this limit was reached when the rock temperature was about 100 deg. Fahr. It was then found necessary to use auxiliary methods, either to avoid heating the air used for ventilation or to cool it after heating. It is preferable to keep the air for ventilation at as low a temperature as possible, either by insulating the air-conveying

Name of tunnel	Simplon	St. Gothard	Loetschberg	Mt. Cenis	Arlberg	Ricken
Tunnel length, ft.	65,042	49,147	47,680	42,145	33,600	28,200
Maximum elevation of range penetrated, ft.	9,320	9,380	9,650	9,675	6,660	3,620
Maximum overlying depth, ft.	7,000	5,570	5,550	5,430	2,360	1,740
Maximum rock temperature, deg. Fahr.	130	88	94	85	65	74
Approximate number of men in tunnel	800	400	600	250	700	140
Explosives used per 24 hr., lb.	1,100	660	900	440	770	500
Ventilating air, per sec. ft.	1,270	70	300-350	18-35	100-200	110-140

VENTILATION STATISTICS FOR SIX LONG AND DEEP TUNNELS.

pipes, if any, or by insulating the walls of the heading or tunnel with a thin coat of cold water by means of pulverizators or jets. Both systems are costly, especially the second one, unless cold water is available under natural pressure.

The problem of ventilating deep tunnels during and after construction has become a complicated one, requiring in itself the constant attention of an engineering staff and laboring force especially assigned to this work. The following figures published by Dr. Pommetti for the Simplon tunnel, north side, give only a small idea of the advantages gained by an efficient ventilating and refrigerating system: Out of a total of 3,445,754 man-shifts only 52,677, or 1.53 per cent., represented sickness. There were 37 deaths caused by illness and 30 by accident.

The table gives the amount of air provided for ventilation during the driving of six long and deeply overlaid tunnels.

RECORDS FROM THE UPPER ATMOSPHERE*

On December 17, 1912, a balloon, liberated by Professor Gamba, from the aerological observatory at Pavia, Italy, reached an altitude of 37,700 metres (123,600 ft.; 23.4 miles). The balloon used was made of para-gum, was inflated with hydrogen, and was provided with a parachute. Its diameter, 1.9 m. (74.8 in.) was made necessary by the special apparatus to be carried. The flight was entirely normal, and the balloon returned to the earth at a distance of only 24¼ miles.

The minimum atmospheric pressure recorded was 2 mm. (.078 in. of mercury, .038 lb. per sq. in.), this of course at the greatest altitude. The minimum temperature registered was 56.9 degrees C. at the height of 19.730 m. (64,800 ft.). The stratosphere was encountered at 12,385 m. (40,600 ft.), with a temperature of 55.5 degrees C.; the temperature in it remained constant for some time, then increased and later diminished, again increased and reached finally 51.6 degrees C. at the maximum altitude registered.

What really are the explanations of the unusual phenomena observed at the higher altitudes, the layers of heat inversions, their variations according to the seasons and their influence upon general meteorology?

As a matter of fact, to the gases contained in the atmosphere are due the different observed phenomena; for example, combustion, breathing, etc. Upon the surface and at points very close to the surface of the earth, the constituents of the atmospheric air are known with great precision; the gas which we breathe consists of a mixture of 78 volumes of nitrogen and 21 of oxygen; the 100th part remaining contains carbonic acid, aqueous vapors, small proportions of argon, and other rare gases such as helium, neon, etc. It should be noted that the aqueous vapors and carbonic acid occur in different proportions in different specimens of air that have been analyzed. The average weight of the atmosphere at sea-level corresponds to the weight of a column of mercury 760 mm. high (29.9 in.).

When we leave the lower altitudes, either by climbing a high mountain, or by balloon, we observe that the density of the air decreases, that combustion is made with more difficulty, that breathing becomes more laborious; all these phenomena indicate to us that the thickness of the gaseous envelope is not without its limits. Actually, this layer is carried around with the earth in its rotation upon its axis, and from this it follows that in the higher regions the gaseous molecules will be greatly decreased for the reason that two forces act upon them—gravity, which tends to bring them together at the centre of the earth, and the centrifugal force, which, affecting them inversely, tends to drive them away from the earth.

Through some limiting surface, one of these forces becomes predominant; if the centrifugal force is in excess, the particles are no longer retained by the earth, are driven away

*Abstract from *La Nature*.

from its influence, and consequently cease to be a part of our atmosphere. Calculation shows that this surface lies about 5 or 6 radii of the earth distant from its surface. This corresponds approximately to one-tenth of the distance from the earth to the moon. Its theoretical limit is 34,000 km. (21,200 miles).

Shooting stars make possible exact measurements of the thickness of our atmosphere. Aerolites entering it with great velocity meet the gaseous atmospheric particles, become heated by friction up to luminosity, and therefore become visible to an observer situated upon the surface of the earth. Simultaneous observations made at different localities enable us to calculate by triangulation the height at which this atmosphere was met by the aerolite. The greatest altitudes obtained by this process are in the neighborhood of 200 to 300 km. (125 to 187 miles).

From the physical viewpoint, the lower part of the atmosphere may be considered as comprising three layers.

The first reaches from the earth's surface up to approximately 3,000 m. (10,000 ft.). In this zone there exists almost the entire quantity of water vapor and dust; here the phenomena depend upon the inequalities of the earth's surface, because these cause and here originate nearly all of the greater atmospheric disturbances. The temperature here decreases very irregularly, and often shows the phenomena of inversion; that is to say, that instead of decreasing as the altitude increases, it becomes warmer in certain layers, the thickness of which can reach 1,500 to 2,000 m. (1 to 1¼ mile). This atmospheric layer has been very thoroughly studied by means of observers in balloons, by captive balloons, and principally by kites.

The second layer lies from 3,000 up to 10,000 m. (6 miles). In it are found only a few clouds, and the temperature uniformly diminishes. At 10,000 m. are observed the lowest temperatures, with some very attenuated clouds, which consist of ice particles; also at about this altitude man is obliged to halt. On July 31, 1901, Berson reached a height of 10,800 m. (35,500 feet).

By kites and by observers in balloons we have been able to explore the lower levels of the second layer to between 5,000 and 6,000 m. Contained in these two first layers is that which Leon Teisserene de Bort has called the troposphere, because of his theory that in this region occur the vertical movements of the air.

The remainder of the atmosphere belongs to the third zone, which is known as the stratosphere, for the reason that in it the vertical movements of the air do not exist. To explore this layer thoroughly it is necessary to use the free balloons; that is to say, small balloons made of paper or caoutchouc, liberated at the earth's surface and to be recovered later if possible.

The caoutchouc balloons are similar to those given to children, but of better quality and larger, their normal diameter varying from 0.4 up to 2 m.

During flight the diameter can reach 6 to 8 m. before the caoutchouc will disrupt. The size most ordinarily used is 6 m. in diameter for the paper balloons, and from 1.2 m. up to 1.5 m. for the caouchouc balloons. The size necessarily depends on the instruments which it is desired to send up, and they must be very light.

The balloons are inflated with hydrogen in order that their lifting power may be as great as possible. They rise with great rapidity at the commencement of their flight, from 4 up to 8 m. per second, reach their highest point and return to the earth. Generally, at their maximum altitude, the caouchouc balloons explode. For that reason it is necessary to protect the apparatus and the valuable records against a destructive fall, for which is used an ingenous device. The balloon is covered with a parachute arrangement which at the moment of exploding opens and controls the speed of descent. Tandem balloons are often sent up of which only one explodes, the second remaining intact and checking the fall.

If it is desired to take a specimen of the air, the balloon carries up finely pointed tubes in which there is as nearly perfect vacuum as possible; by means of a clock-driven device the point is broken at will and is automatically closed some minutes later. Explorations by sounding balloons are being made in all parts of the world.

RESULTS OBTAINED.

At the sea-level the temperature somewhat regularly decreases in the first 2,000 to 3,000 m., often having inversions; later it cools more rapidly and regularly up to an altitude vary-

ing from 8,000 to 14,000 m., according to the locality. In French regions, at approximately the altitudes named, there usually are observed the lowest temperatures. If the investigation is carried farther upward, the temperature is generally sensibly increased (a warm layer), and later decreases again very rapidly and irregularly. This layer, where the temperature is almost constant and does not have regular variations either way, is called the isothermal layer or stratosphere.

The Pavia balloon, which was mentioned at the beginning of this article, gave similar indications; there should be mentioned also the Belgium balloon, liberated on November 5, 1908, which registered -67.8°C. at an elevation of 15,500 m., and only -63.5°C. at 29,040 m.; and that sent from Trappes on August 10, 1907, which showed -55.6°C. at 13,000 m. and -51.6°C. at 28,000 metres. This division of the temperature is found commonly everywhere, changing only according to the meteorological situation in the temperate and polar regions.

A long time ago Teisserenc de Bort showed that the altitude of the stratosphere varied with the meteorological condition: low (8,000 to 9,000 m.), and warm (-45° to -55°), during atmospheric compressions it reaches higher altitudes and becomes colder in the anti-cyclones, where it can reach a temperature of -60° to -75° at an altitude of approximately 14,000 metres.

Another very interesting fact: only seldom are temperatures as low as -80° observed over the polar and temperate zones, while that temperature often is reached and even exceeded over the equatorial regions, where the stratosphere is found only at altitudes of from 16,000 to 18,000 m.; the observations made by Teisserenc de Bort over tropical seas and over Lapland during the years 1906, 1907, and 1908 showed that for the upper regions the temperature is less cold at the poles than in the equatorial regions, although upon the earth's surface the polar temperatures are the lower by from 20 to 50 degrees. The atmospheric movements that take place at the equator produce, doubtless, powerful and sudden decreases of air pressure, which cause a lowering of the temperature.

Further, the temperature decreases more rapidly in the equatorial regions for the reason that the air is drier and it chills more completely, hence the stratosphere lies at a higher altitude; for that reason, approximately at 16,000 or 17,000 m., temperatures are observed from 20 to 30 degrees colder above the equator than over Lapland.

Finally, the various observations made it possible for the Austrian meteorologist, Hann, to determine the consistence of the air at different altitudes; and that atmosphere, the components of which were given above as for the earth's surface, is not constant; only 18 per cent. of oxygen at 10,000 m., 15 per cent. at 20,000 m., and 7 per cent. at 35,000 m., while the quantity of nitrogen becomes greater, respectively 81, 84, and 93 per cent.

It would be difficult to remain indifferent in the face of such remarkable discoveries that lead to a more complete knowledge concerning the medium in which we live, making it possible that we shall more thoroughly understand the mechanism of the air movements. We owe much to the scientists conducting these investigations.

COMPRESSED AIR ON THE AUTOMOBILE

BY C. S. COLE.

There is noticeable in the demand of the public an inevitable and sure feeling that the limitations of the electric starter are measured directly by the capabilites of the storage battery. The very high weight of this item precludes, for other than lighting the lamps, a life and service reconcilable with modern motor car development. To equip a car with a battery for lighting the lamps while the car is stopped is eminently practicable, and batteries for this service in connection with a properly designed lighting dynamo can be had which will give reasonable service for four or five years.

If electric starting is to be included in the service from the battery, and an equal length of life without the high cost of renewal and repairs is desired, the weight of a battery of guaranteed ruggedness and capacity would be such that no manufacturer or owner would sanction it, as the weight of the battery alone would very nearly equal that of another passenger.

EFFICIENCY OF THE AIR STARTER.

Recent developments in highly efficient air starting systems have pointed the way toward relief from battery maintenance and also opened up the field for pneumatic gear shifting

air brakes which permit a car to be driven with all the ease a motorman controls our modern high speed electric railway trains in heavy interurban traffic. There are available in the market to-day highly efficient and compact units consisting of an air starting distributer, electric lighting generator and air pump, all within a single casing and having only one point of drive.

These starters will spin the largest motors at a speed of 200 or 250 revolutions a minute, which eliminates the past necessity of turning it over at 100 or less for ten or twenty minutes to start in cold weather. In special cases they can be adjusted to spin the motor much faster if desired for a short time. With speeds of 250 and higher an engine will start almost instantly even in cold weather because the violent suction established in the carburetor bodily pulls the gasolene into the cylinder chambers without losing it along the walls of the inlet manifold, for which reason the slower speed electric starter must turn over for a longer time and gradually work this cold fuel up into the motor.

Further, these new machines in a unit case weigh in the vicinity of only forty pounds and furnish everything needed for electric lights, air starting, pneumatic or electric gear shifting, railway air brakes, tire inflation and compressed air for cushion and upholstering blow-off. The development of a reliable method for obtaining high pressure compressed air and a system designed to hold it absoluetly without leaks has made all this possible.

AIR CUSHIONING.

Many persons are working at the present time upon various air suspensions for the car to give a resiliency sufficient of realizing liberation from the rubber tire. These machines will undoubtedly help this field of endeavor along incidentally, as the great stumbling block to date has been to get the air at high pressure with the certainty necessary in a spring suspension. While upon this vital question it may be stated that many practical engineers believe that logical solution of the tire question is transference of the compressed air in its perishable container of rubber and cotton in the tire to some metal medium between the wheels and the car.

Among many advantages of air starting is the elimination entirely of all forms of gears, chains, etc., in connection with the start. These all make noise in varying degree, while air drives the pistons down with a force of many tons in an absolutely inaudible manner. Coincidently pulling the car and starting the motor on magneto has no bad effects with air as it has with electricity, and in fact is to be recommended as of great use in the following way:

On starting from the curb the car is put in low or second and the switch thrown on magneto with the clutch in. If the air button is now pressed the modern six, or in fact any six, will pull away from the curb in a manner that defies detection from an electric car and there is absolutely no shock when the motor gets the first explosion, since the air pressure is as high as the explosion and the two shade together without difference at the crankshaft. This practice eliminates the old necessity of starting the motor before starting the car and makes a much more convenient, distinctive and rational getting away; while after the actual start the driver proceeds with his other gears exactly and unconsciously as though he had started the car with the clutch.

With the developed systems referred to this is standard practice for starting, backing and all work where the car is moved in small distances, and its realization takes a tremendous amount of work and wear off the clutch, while giving a control of the car in tight spots which is absolutely noiseless and free from that commotion under the hood usually associated with starting or traffic congestion. A six cylinder under the force of the compressed air is for the time being transformed into an unlimitedly powerful steam engine and is handled as such in a manner exactly the same as an electric car, both as to noise and flexibility, but with greater power.—*The Sun, N. Y.*

The lack of comparable and accurate statistics of coal-mine accidents in the United States has led the Bureau of Mines to collect such data, and the results of these investigations have been compiled by Mr. F. W. Horton, in Bulletin No. 69, entitled "Coal Mine Accidents in the United States and Foreign Countries," which has just been issued. Copies of this bulletin may be obtained by addressing the Director, Bureau of Mines, Washington, D. C.

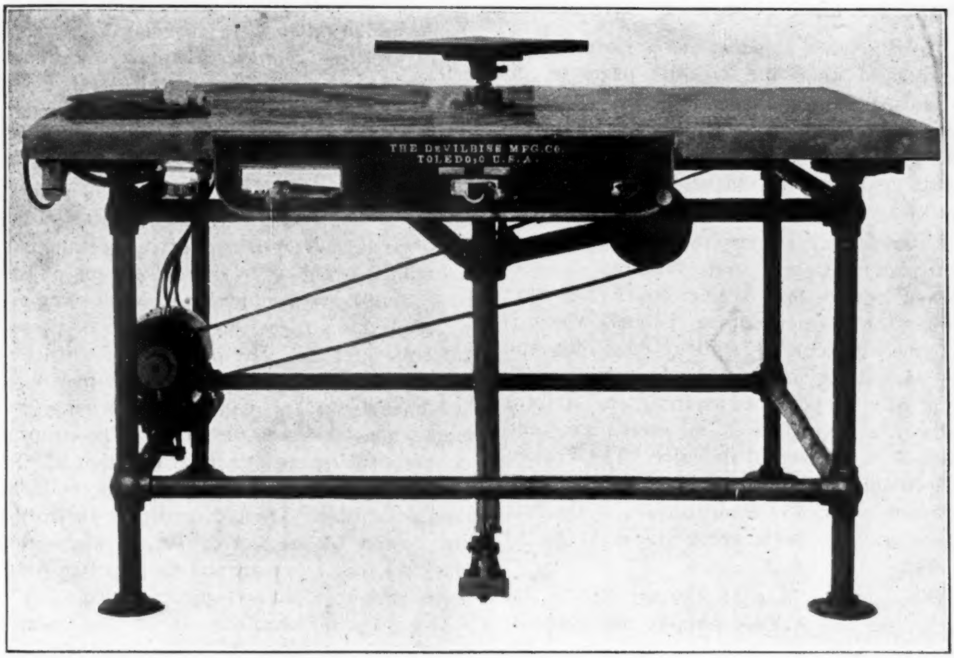


FIG. I.

AUTOMATIC PNEUMATIC PAINTING APPARATUS

For covering comparatively small objects and parts with paint, japan, enamel, lacquer, etc., the machine shown in the illustration is very effective.

The article to be painted is placed on the elevated platform which is rotated by means of a Westinghouse small motor mounted under the table. The paint, or other material, is sprayed on by means of compressed air, thus covering the article more rapidly than can be done by brush work, reaching all parts of carvings, irregularities, etc., and showing no brush marks.

When it is necessary to remove the fumes, the revolving stand is mounted inside the hood illustrated, which is provided with a Westinghouse ventilating fan.

The device is manufactured by the De Vilbiss Mfg. Co., Toledo, O.

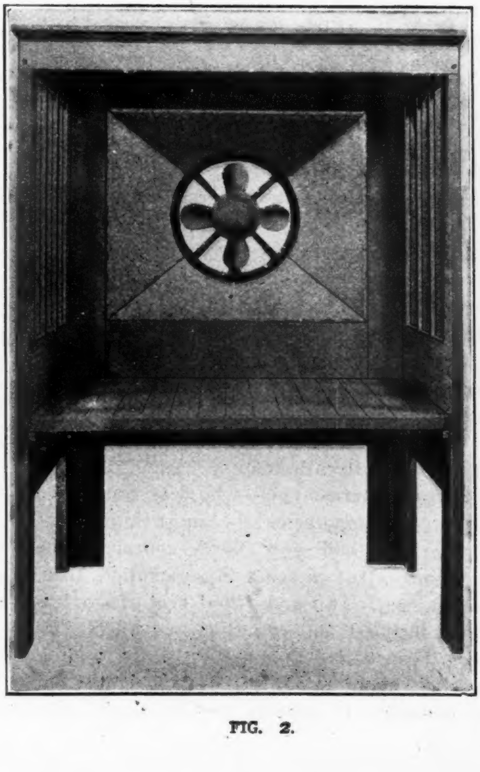


FIG. 2.

The number of locomotives ordered in the United States during the year 1912 was 4,515, which may be taken as a fair average figure for the period of 10 years since records dealing with the subject were instituted.

PRINCIPAL LONG TUNNELS OF THE WORLD

The *Engineer*, London, has prepared tables, reproduced upon the opposite page, of the world's greatest tunnels. Various notes are appended relating to some of the tunnels individually. It will be noticed that the United States makes a very insignificant showing in the list.

Electric traction is employed in the Simplon, Lötschberg, Ricken, and Jungfrau tunnels. Steam locomotives burning liquid fuel have been tried in the Arlberg Tunnel, which is extremely difficult to ventilate efficiently, and are exclusively used in the Caldera Tunnel. It is now proposed to electrify the Arlberg Railway between Bludenz, the great tunnel, and Landeck, a distance of 25 miles. The Lötschberg-Simplon Railway—Spiez to Brigue, 46 miles—is electrically equipped, and is the first Alpine railway with great traffic to be so worked.

Although two lines of way are laid in the Lötschberg and Arlberg tunnels, the approach lines are single.

The Mount Cenis Tunnel is hardly appropriately named, as the culminating point of the Mont Cenis lies 17 miles to the east of the tunnel, which is carried through the Col de Frejus.

The Ricken Tunnel is on the new railway from Utznach to Wattwil, 9 miles in length, which links up the industrial Toggenberg Valley with the Lake of Zurich. It is the second longest single-line tunnel in the world.

The tunel through the Col di Tenda is on a branch line from Cuneo—55 miles from Turin—to Vievola. The latter station at the southern portal of the tunnel is the present terminus of the line, which is now being extended down to the valley of the Roya to Ventimiglia, 32 miles away. The earliest mention that we have of tunnelling in connection with the Alps concerns the Col di Tenda, and dates back to the fifteenth century. Anne, Duchess of Savoy—married 1433—who was considered by her contemporaries the most intellectual woman who had ever lived, conceived the grand project of piercing this mountain, then, and for nearly two and a half centuries afterwards, the best and easiest pass available between France and North-West Italy, with a tunnel at about one-third of its height from the summit. It appears beyond doubt that the works were begun, but at the death of Anne in 1463 they were abandoned. After a lapse of three centuries they were resumed in 1782 by order of Victor Amadeus III., King of Savoy. The excavation of the mountain was continued, although not vigorously, until 1794, when it was stopped in consequence of the invasion of Savoy by the French. The total length of the tunnel would have been about 3,000 yards, and by means of it a precipitous sugar-loaf ascent of 1,300 ft. to the top of the pass would have been avoided. With some alterations this project was carried to a sucessful issue in 1883. The new road constructed in that year penetrates the Tenda by means of a tunnel about 1½ miles long, forming the longest road tunnel in the world. The altitude of the north entrance is 4,300 ft.; that of the south 4,196 ft. From the central point both ends are visible. The old road over the fortified heights of the Col di Tenda, where the Maritime Alps terminate and the Ligurian Alps begin, is now closed to ordinary traffic.

The Jungfrau Railway is of one metre gauge, and for most of the distance requires a rack rail, the Strub being the type employed The tunnel commences at Eiger Glacier, 7,621 ft. above datum, and extends to Jungfraujoch. The dimensions of the tunnel are:—Maximum width, 11 ft. 9¾ in.; maximum height, 13 ft. 11 in.

The Severn Tunnel is the longest subaqueous tunnel in the world.

The Turchino Tunnel is on the new line from Genoa to Asti, which has a total length of 62 miles, and a tunnel mileage of more than a quarter of that of the whole line. The gradient of the great tunnel is 1 in 83 rising from south to north.

The Albula or Engadine Tunnel lies between the two stations of Preda and Spinas. It is the highest of the Alpine series, with the exception of the Jungfrau, but the latter belongs to rather a different category.

The Peloritana Tunnel pierces the ridge sheltering Messina from the north.

The Gravehals Tunnel, on the Bergen Railway, runs through the Urhvode Mountain at a depth below its summit of 1,698 ft. At its east entrance is Myrdalen Station, and at its west entrance Opset Station. The tunnel is nearly level, rising only 55 ft. from west to east. Immediately east of Myrdalen Station is another long tunnel, the Reinunga, 1,968 yards.

TABLE I.—*Tunnels in Europe of Two Miles in Length.*

Ref. No.	Name of tunnel.	Country.	Length.	Summit level.	Opened for traffic.
			M. yds.	Feet.	
1	Simplon*	Switzerland–Italy	12 458	2313	1906
2	St. Gothard	Switzerland–Italy	9 564	3788	1882
3	Lötschberg	Switzerland	9 55	4077	1913
4	Mont Cenis	France–Italy	7 1730	4248	1871
5	Arlberg	Austria	6 404	4300	1885
6	Ricken*	Switzerland	5 610	650	1910
7	Tauern	Austria	5 546	4020	1909
8	Ronco	Italy	5 277	—	1888
9	Tenda*	Italy	5 56	3260	1899
10	Karawanken	Austria	4 1683	2088	1906
11	Jungfrau*†	Switzerland	4 834	11,220	1912
12	Borgallo	Italy	4 700	—	1887
13	Severn	England–Wales	4 636	—	1886
14	Turchino*	Italy	4 10	—	1900
15	Wocheiner	Austria	3 1647	1761	1909
16	Albula*†	Switzerland	3 1150	6133	1903
17	Totley	England	3 950	—	1893
18	Peloritana*	Sicily	3 686	—	1885
19	Gravehals*	Norway	3 516	2844	1909
20	Standedge	England	3 60	—	1850
21	Woodhead	England	3 13	—	1845
22	Bosruck*	Austria	2 1693	2405	1906
23	La Nertho	France	2 1581	—	—
24	Kaiser Wilhelm	Germany	2 1069	—	1879
25	Echarmeaux	France	2 1020	—	1895
26	Blaisy	France	2 990	—	—
27	Sodbury	England	2 913	—	1903
28	Credo	France	2 800	—	—
29	Vizzavona*†	Corsica	2 778	2971	1889
30	Disley	England	2 346	—	1902
31	Col de St. Michel*†	France	2 292	—	1901
32	Bramhope	England	2 234	—	1849
33	Festiniog*	Wales	2 206	—	1879
34	Cowburn	England	2 182	—	1893
35	Meudon	France	2 134	—	1900

TABLE I.—*Tunnels in Europe of Two Miles in Length (continued).*

Ref. No.	Name of tunnel.	Country.	Length.	Summit level.	Opened for traffic.
			M. yds.	Feet.	
36	Giovi	Italy	2 45	1890	—
37	Col des Loges*	Switzerland	2	3200	—
38	Cremolina*	Italy	1 1748	—	—
39	Cairasca*	Italy	1 1520	—	1906
40	Hauenstein	Switzerland	1 1210	—	—
41	Semmering	Austria	0 1333	2940	1850

TABLE II.—*The Longest Tunnels Out of Europe.*

Ref. No.	Name of tunnel.	Country.	Length.	Summit level.	Opened for traffic.
			M. yds.	Feet.	
42	Hoosac	United States	4 685	—	1876
43	Khojak‡	Baluchistan	2 769	—	1892
44	Suram	Caucasus	2 750	—	1895
45	Caldera*	Peru	1 1320	15,774	1893
46	Beacon Hill*	China	1 644	—	1910
47	Transandine*†	Chile–Argentine	1 551	10,500	1911

TABLE III.—*Long European Tunnels now being Constructed.*

Ref. No.	Name of tunnel.	Country.	Length.	Summit level.	
			M. yds.	Feet.	
48	Hauenstein Base	Switzerland	5 0	—	—
49	Somport*	France–Spain	4 1512	—	—
50	Grenchenberg	Switzerland	4 0	1787	—
51	Puymorens*	France–Spain	3 317	—	—
52	Mont D'Or	France–Switzerland	3 1395	—	—

* Single-line tunnel. † One metre gauge railway. ‡ Standard gauge of India.

PRINCIPAL LONG TUNNELS OF THE WORLD.

The Standedge Tunnel, on the Huddersfield and Manchester Railways, between Marsden and Diggle stations, held pride of place as the longest in the kingdom until the Severn was completed. The original single line tunnel has been augmented by a second and also by a double-line tunnel, all abreast, driven through the "millstone grit" series of the Pennine Range. There is also a fourth tunnel, of much smaller section, at a lower level, and 114 yards longer than the above, through which flows the Huddersfield Canal, with 8 ft. depth of water.

La Nerthe, the longest tunnel in France, is ventilated by twenty-two shafts, one of which is 607 ft deep.

The Kaiser Wilhelm tunnel, the greatest work of this kind in the German Empire, is on the line Coblenz-Treves, and between the two stations of Eller and Cochem. With the rapid increase of traffic between 1895 and 1900 the air became so foul as seriously to inconvenience platelayers and passengers. It was ventilated in 1901 on the Saccardo system, as successfully applied in the St. Gotthard. This system has been installed also in the Wocheimer and other tunnels.

The tunnel under the Col des Loges is on the very steeply graded line from Neuchâtel to Chaux de Fonds. At the north end of this tunnel is a solitary station, Les Convers, and immediately beyond the line enters another tunnel, three-quarters of a mile long, under Mont Sagne. The open space between these tunnels is so short that it might almost be a shaft.

The Cairasca Tunnel is on the approach line to the Simplon Tunnel from Domodossola. It is a spiral tunnel and the longest of that type in the world, which distinction is now being erroneously claimed for the Transandine Tunnel. The difference of levels between the south and north portals of the Cairasca is 307 ft. None of the seven spiral tunnels on the St. Gotthard Railway is more than one mile in length and none makes a greater ascent than 118 ft.

The Hauenstein Tunnel is on the highly important section of the Federal Railways between Basle and Olten. The gradients on the approaches to and inside this tunnel are so steep that a base tunnel is now under construction.

The Semmering was the first Alpine tunnel. It pierces the Noric chain near the summit of the pass. The Semmering Railway, from Vienna to Trieste, was built for the Austrian Government by the engineer Carlo Chega, between the years 1848-54.

The Hoosac Tunnel, between Troy and Fitchburg, took twenty years to construct, but there were several suspensions of work.

The Khojak Tunnel is the longest in Asia. It pierces an historic pass across the Khwaja Amran offshoot of the Toba-Kakar Mountains. It is on the Chaman extension—29.35 miles—of the Sind-Pishin section of the North-Western Railway of India, which extension was built between the years 1888-91 in consequence of the fear of Russian aggression. Two lines are laid through the tunnel. The gauge is the standard gauge for India, *i. e.*, 5 ft. 6 in. When railways were first proposed in India it was considered that a gauge wider than the normal was desirable, as the narrower would be inadequate against cyclonic storms, so frequent at certain seasons of the year. The Khojak, like most other tunnels near the northwest frontier of India, is guarded at each end by strong iron gates.

The Puymorens Tunnel is on a second new Trans-Pyrenean line to connect Aix-les-Thermes, on the Mid system, with Ripoli, in Spain. The French station at the tunnel mouth is Hospitalet. Both of these Trans-Pyrenean Railways have decided to employ electric traction, and therefore steeper gradients than are practicable with steam propulsion have been introduced.

The following long tunnels are projected:—Faucille Pass Railway, Lons le Saunier to Heyerin, three tunnels, 6.6, 9.4, and 4 miles in length respectively; Mont Blanc Railway, Chamonix to Courmayeur, two tunnels, 8 and 3 miles in length respectively; Splugen Railway, Thusis-Rothenbrunnen-Chiavenna; Tunnel, 17 miles; Rigoroso Tunnel, between Genoa and Tortona, 12¼ miles.

LIQUID AIR MINE RESCUE APPARATUS

Liquid air would seem to be specially adapted for use in mine rescue apparatus. It is the most condensed form of air, representing about 800 times its own volume of gas, and the liquid evaporates into the gas by natural absorption of heat. The liquid is carried at

atmospheric pressure, so that no heavy cylinder is required for carrying it.

Coming to the details of application it was no easy proposition to satisfy all the conditions. In the first place it was necessary to evolve a simple form of apparatus to control in an adequate and practical way the liquid air in a breathing dress, as also to find a suitable means for transporting the air below ground, whilst it was, of course, imperative that the plant and process for the production of the air, containing from the outset a large percentage of oxygen, should be free from complications and not unduly costly in maintenance.

The "Aerophor" apparatus, here to be spoken of, is the result of years of experiment and careful development and has not been long in active and successful employment, but is already used by many important British rescue stations a typical one being the Elsewick (Newcastle) Station. This station, in charge of first and second officers, will control a number of sub-stations which will each be in charge of a superintendent. In addition to the necessary complement of rescue apparatus, each of the sub-stations will be furnished with a fire pump of 400 gallons' capacity per min. and a tender. The fire pump at Elswick Station is of 500 gallons per min. capacity. Since the establishment of the last-named Station—three years ago—the fire calls have averaged one in every five weeks. The Station is fortunate in possessing an ideal gallery in the form of a disused clay pit, in which the air is normally so foul as to extinguish a safety lamp. The height of this gallery varies from 10 ft. to 3 ft. 6 in., and for clearing it a Sirocco exhaust fan is installed.

So far as the rescue apparatus are concerned, the equipment is distinctly cosmopolitan, practically every type being represented, and every man passing through the station is trained in the use of each, though for all serious work the liquid-air apparatus is solely employed.

THE AEROPHOR.

The "Aerophor" liquid-air dress consists of a strong canvas jacket, to the front of which the breathing bag is attached, the liquid-air container being attached to the back. This part of the jacket is lined with thick felt, and between it and the pack is an air space for further insulation to protect the wearer's body from the cold. The container is a nickel case shaped to fit the back, the interior of the case being packed with asbestos wool, which absorbs the liquid air so that it does not run out even if the container is turned bottom up. The top of the case is provided with three openings, one for the filling, one for the escape of air whilst the case is being filled, and the third for conducting the air to the breathing bag. The outside of the case is effectively insulated and enclosed in leather. The caustic potash is contained in an outer case with a hole at each end. This cartridge is only to afford a means of exceptional reserve for use under extreme exertions, and during the third and fourth hour, so that only a very small percentage of the air is breathed twice. The mask is made of a special composition of canvas and rubber. Inside, near the cushion which ensures an air-tight joint with the face, is a flexible metal band which allows the mask to be shaped to fit any face in a few seconds. The mask is held in position by four straps, which are attached to the cap, the latter being made of asbestos cloth with a thick leather pad at the top to protect the wearer's head. At Elswick Station the half mask is almost exclusively employed, and from the point of view of comfort at any rate, it certainly leaves nothing to be desired.

As the air evaporates it passes out of the pack along a tube down the side and underneath the pack to a T-piece, where it enters the circulation, and then on to the breathing bag. On its passage it gets gradually warmed up, and is merely pleasantly cool as it passes through the valve to the mask. The expelled air passes through the exhaling valve and a tube leading to the caustic-potash cartridge. Immediately before this, however, there is an escape valve which allows excess air to pass to atmosphere. In the case of violent temporary exertion rather more air than that coming from the pack would probably be required, the balance would then be made up by the exhaled air passing through the cartridge and afterwards mixing with the fresh air from the pack, and so on to the breathing bag.

A unique feature of the apparatus is its ability to supply air to a second man from the escape valve. This is accomplished by fixing to the escape valve a tube carrying at its other end a mouth-piece and nose clip. The air

thus supplied, although it has been exhaled by the wearer of the apparatus, is quite good enough to be breathed a second time, as it contains from 30 per cent. to 40 per cent. of oxygen.

It will be seen that the apparatus is entirely independent of the control of the wearer, and depends for its action upon the natural law which causes the liquid to evaporate, the rate of such evaporation being controlled by the insulation between the inner pack and the outer atmosphere. This, however, is not appreciably affected by a change of from 20 deg. to 30 deg. F. in the temperature of the outer atmosphere, as the difference is always some 400 deg. F.

AIR LIQUEFYING PLANT.

The plant for the production of the liquid air is installed in a room immediately at the rear of the main building. This consists of a motor-driven three-stage compressor which draws in the air through a purifier and delivers it at a pressure of 3,000 lbs. through two cylindrical tanks, arranged in series, in which the moisture and remaining impurites are absorbed. It then passes on in part to a liquifier and in part to an expansion engine. The liquefaction is accomplished through the air being cooled in the expansion engine below the critical point, and, meeting the other air current, the liquifier turns the latter into liquid, which is collected and drawn off in a continuous stream through a tap. The power developed in the expansion engine is retransmitted to the motor by means of belt and pulley. The plant is equal to the production of 20 lbs. of liquid air per hour, at a cost of slightly less than 2 cents per lb.

The method of charging is as follows:—The complete dress is fixed up ready for wear, suspended on a spring balance slung from a tripod. The relief valve is opened and the full charge of air (10 lbs.) poured in; the funnel is then removed, the two plugs screwed down and the dress is ready for service. It may be noted that an alarm watch is carried in a pocket in the front of the jacket, and upon the back of this watch is recorded the time of charging and the length of time the charge will last. The watches, all regulated to that of the leader of the party, are set to ring at a certain time to warn the wearer to return to the base.

The liquid air used contains some 60 per cent. to 70 per cent. of oxygen. Each pound of the liquid furnishes about 12 cub. ft. of oxygen, which on a conservative estimate is calculated to give 20 minutes' supply of air, and as the nitrogen evaporates at a slightly higher rate than the oxygen, the content of the latter is a steadily increasing factor. The weight of the dress fully charged is 30 lbs., a corresponding decrease in the weight taking place as the charge of liquid air evaporates.

That the use of liquid air in the "Aerophor" apparatus does not call for any special knowledge on the part of the wearer was very graphically illustrated a short time ago, during a demonstration at the Rotherham Rescue Station, when a bricklayer's laborer was equipped with the dress. This man, without any previous knowledge of any form of breathing apparatus, performed a set task of manual labor, and on its completion was pronounced by the doctor to be in first-class condition. The man expressed himself as perfectly comfortable; he said the breathing was easy and that he had an ample supply of air.

The difficulty of transporting the liquid air has been overcome by the provision of double-walled metal vessels, with a vacuum between. The vessels, which have a holding capacity of 50 lbs., terminate in a special-shaped very thin neck, which is always open to atmosphere, as on account of its enormous expansive force it would be impossible to employ hermetically-sealed cylinders. In the vessels described the air can be transported any reasonable distance, the loss by evaporation during such transportation being of no consequence.—*Condensed from Colliery Guardian.*

BUSINESS QUACKS

But the swarm of half-baked "efficiency experts" who are seeking employment as "business doctors" on the strength of a correspondence course in some "Institute of Efficiency" or solely on their claims to expert knowledge and who ought not be trusted to doctor a cat—such men as these are rapidly discrediting the whole efficiency movement in the minds of intelligent business men. —*Exchange.*

In a recent reissue of a U. S. patent for a mechanical cashier (cash register) there are 269 claims.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

W. L. SAUNDERS, - - - - - - - - Editor
FRANK RICHARDS. - - - Managing Editor
CHAS. A. HIRSCHBERG, - - Business Manager
W. C. LAROS - - - Circulation Manager

PUBLISHED MONTHLY BY THE

Compressed Air Magazine Company
Easton, Pa.

New York Office—Bowling Green Building.
London Office—165 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.
Those who fail to receive papers promptly will please notify us at once.
Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa., Post Office.

Vol. XIX. JANUARY, 1914. No. 1

CONTENTS

A YEAR OF PROGRESS IN COMPRESSED AIR

The widening use of compressed air in the arts has continued during the past year with unabated progress. In addition to minor instances, where air has enlarged its usefulness in machine shop practice, in lifting liquids and in operating all devices which are used underground, we have the extension of pneumatic power to the automobile. So far there has been perfected a compressed air starting device and pneumatic metallic spring. The starting device is no longer in experiment. Its application to an automobile affords opportunity to use air under compression for starting the engine, for pumping the tires and for cleaning purposes. Its advantage over the electric system of starting is especially apparent in cold weather, as the compressed air starter throws the engine promptly into active service, drawing the gasoline rapidly because of the rapid movement of the engine, while with the electric starter, the process being slow, like that of hand cranking, the gasoline cools and deposits so that it is not so easily sprayed and ignited.

The metallic air spring invented by Mr. George Westinghouse is now an acknowledged success in automobile service. It was originally intended to replace the pneumatic tire, then it was thought that these air springs might replace the metallic springs, but a plan seems to have been perfected by which the air spring simply adds greater elasticity to the regular spring, and in doing this it eases the shock throughout the apparatus. These air springs are upright cylinders, one of which is attached to each of the four metallic springs in such a way as to separate through an air cushion the body of the car from the axle. These springs are pumped up by the ordinary motor pump, and in this way an opportunity is given to replace leakage. A motor car equipped with these air springs may ride at full speed over a rough road without serious effect to the occupant of the car.

The most important advance in compressed air practice during the year has been in the turbo air compressor. Next we might mention the introduction of plate or lift valves of the Rogler pattern. The turbo has proven its value as an air compressor up to a little above 100 pounds pressure. Machines of this type, with steam turbines driving air impellers, have been

in constant practical operation during the year, generating large volumes of compressed air with safety and with reasonable economy. The largest compressed air plant in the world is now in service generating air power for the South African Gold Mines, and the fact that this plant is being enlarged from time to time is an evidence of the success of the turbo system. In America turbo air compressors are coming into use for air at all pressures up to 100 pounds. Large installations have recently been erected for blast furnace practice, both the steam and air ends being turbines. The Tennessee Coal, Iron & Railroad Company have recently installed a machine of this class which is giving a volume of 55,000 cubic feet per minute at from 18 to 22 pounds pressure. This machine may be run either through exhaust or live steam, a regulator being supplied by which it is shifted from one to the other as the exigencies of the case demand.

Machines of this type may also be driven by electric power. Several designs have been built and are now in operation, by which electric motors of normal sizes and speeds are used to drive turbo air ends through herringbone gears, encased and immersed in oil, thus bringing up the speed of the air end so as to attain maximum efficiency. So well have these machines been designed that there is an entire absence of noise and practically no wear on the gears.

The great importance of the turbo air compressor lies in the volumetric capacity of a machine of small size and light weight. The weight of a reciprocating apparatus of equal capacity is thus practically divided by four.

Little attention is required except to start and stop the machine and the expense of oil is reduced to a minimum because the machine pumps the oil around and about the bearings, then cooling it and returning it to its original reservoir for continued use. We look to see during the coming year still further and important developments in this line of compressed air generators.

W. L. SAUNDERS.

In the literature of ozone at present there seems to be practically no statement which is not flatly contradicted by exactly the opposite statement made by equally high authority.—*Dr. C. P. Steinmetz.*

THE MODEST DEMANDS OF THE BUREAU OF MINES

The estimates of appropriations for the United States Bureau of Mines, for the fiscal year ending June 30, 1915, as approved by Secretary Lane of the Interior Department, have just been forwarded to Congress.

For general expenses of the Bureau of Mines, $70,000.

For investigating mine accidents, $347,000.

For the equipment of mine rescue cars and stations, $30,000.

Equipment of testing plant at Pittsburgh, Pa., $10,000.

For testing fuels, $135,000.

For mineral mining investigations, $120,000.

For inquiries and investigations of petroleum and natural gas, $30,000.

For inspection of mines in Alaska, $7,000.

For books and publications, $2,000.

For lands, leases, etc., for mine rescue cars, $1,000.

The total for the Bureau of Mines is thus only $752,000, an increase over the fiscal year ending June 30, 1914, of $90,000.

The item of $30,000 for the equipment of rescue cars and stations is for the first time placed separately in the estimates and represents an increase.

The $10,000 asked for the equipment of the testing plant is a new item. The money is needed for the purchase of steam and electric equipment. The estimates set forth that the present power and electric service plant at the experiment station is on the eve of breakdown.

For the mineral mining investigations, an increase of $20,000 is asked, from $100,000 to $120,000.

For the inspection of mines in Alaska, an increase of $500 over the previous year is asked. The same increase is asked for books and publications. The item for lands, leases, etc., for mine rescue cars is decreased $1,000.

The item of $30,000 for inquiries and investigations of petroleum and natural gas is for the first time placed separately in the estimates and represents an increase. It calls for inquiries and investigations concerning the mining, preparation, treatment and utilization of petroleum and natural gas, with a view to economic development, and conserving resources through the prevention of waste.

OXYGEN PRODUCTION IN THE UNITED STATES

It is estimated by those who should know that the average production of oxygen in this country is at the rate of 600,000 cu. ft. per day. Approximately one-half of this is supplied by twelve central stations located in the larger cities, and the remainder by plants in individual works.

For welding and cutting, the oxy-hydrogen process is being rapidly developed in this country, both the steel and electric companies making extensive use of this system. The railroads, however, which are such large factors in the use of oxygen in Europe, have not yet adopted this method on any large scale in this country.

The United States government uses considerable oxygen and hydrogen in its different navy yards, but ship builders generally are just beginning to apply the welding and cutting torch in their yards. The range boiler works, tube works and manufacturers of steel barrels, boxes, etc., also are large users of oxygen. It is claimed that there is a scarcity of well-instructed welders, which is due to the fact that the art is still young.

An association recently has been organized among the compressed gas manufacturers, known as the Compressed Gas Manufacturers' Association, with headquarters in New York City. Dr. Hugo Lieber, of the Blaugas Co. of America, is president.

THE PNEUMATIC SIGNALING SYSTEM IN MINES

The importance of a good signal system at shaft and slope mines has often failed to receive the attention it deserves, until some incident has occurred to reveal the inadequacy of signal system in use. The common method formerly employed for transmitting signals between the engine room and the shaft or slope bottom, or from the mine opening to the inside workings was that by which a gong was sounded by pulling a wire, or by making an electrical connection through a wire conductor.

The defects and petty annoyances arising from these systems are numerous. Wires are broken, or false signals are given by falling material coming in contact with the wire; or by someone meddling with the wire by which the signal is transmitted. The spirit of mischief, always prevalent among irresponsible men and boys in mines, has resulted, in some instances, in serious accident due to the meddling with signal wires, which is possible in both of the old systems of signaling.

Much annoyance is also caused by the corrosion of the wires and connections. There is always the possibility, also, that the proper signal may fail of transmission at one or more points, which would prove a source of danger. Interruptions are at times caused by the freezing tight of the wires, or the short-circuiting of the electric current, at intermediate points.

The pneumatic signaling system is devoid of all these defects and possesses the further advantage that the pipe line through which the signals are transmitted can be made to serve as a speaking tube. The system permits of no interruption or meddling at intermediate points, except as the pipe line may be broken by a heavy fall. A pneumatic system of signals properly installed is practically free from any expense for maintenance, during the life of the mine. One of its chief advantages is the fact that it cannot get out of order through disuse; but is always ready when required, after a season of idleness. At such times, an electric system of signaling requires much attention to again put it in shape for use. The pneumatic system is also more exempt from damage in case of fire than either of the other systems of signaling.

The pneumatic system is in use in many of the mines of the Lehigh Valley Coal Co., and it is stated that the Delaware & Hudson Coal Co. have recently decided to install this system in their mines. The same system is in use in the mines of the Oliver & Snyder Steel Co. and in a number of mines throughout the West.—*Coal Age.*

MOVING PICTURES OF A WELSH TIN MINE

It was refreshing to see in a Cinema Theatre a demonstration, at once so interesting and instructive, contrasting as it did most vividly with the nonsenical performances which are ordinarily given in these places of entertainment. And yet, the effect was somewhat novel —when tableaux of the operations at the Dolcoath mine were presented to the accompaniment of slow music, as in a transpontine melodrama. To do the "slow music" justice, however, it seemed almost to keep time with the rythmic movement of the air compressor

which was graphically shown upon the screen, though we missed any representation of the stamps which are almost as necessary to a mine as Hamlet is to the tragedy of that name. A wonderful effect was produced by the passing of a Great Western train under the bridge which separates the line from the actual Dolcoath workings. Equally good was the representation of the roasting of ore in the revolving calciner, and the panoramic effects were also admirably produced. The rock drill display was particularly interesting, and loud cheers followed the admirably reproduced work of the Dolcoath ambulance brigade. Had the films been prepared a few years ago, they would have shown women at work at the buddles, but, yesterday, only one old Cornish woman, the survival of the fittest, was seen at work in the tin yard. The exposition practically concluded with the finished tin going in bags from the mine to the smelter. Another interesting reproduction was "Pay Day at Dolcoath Account House," where 1,300 miners are wont to receive their wages, most of whom go away in the act of counting, to see that they have "the right change."

CRYSTALLIZATION OF STEEL

In a paper read before the September meeting of the British Iron & Steel Institute, F. Rogers takes exception to the common assumption that machine members and other parts of iron or steel have broken as the result of becoming "crystallized through fatigue." The writer has made an extensive study of this subject and reached the conclusion that seldom, if ever, does the structure of the metal become more coarsely crystallized as the result of a load applied intermittently. It appears probable that this idea has arisen from the fact that the fracture of test samples subjected to fatigue tests are frequently of a crystalline character, but an examination would generally show that this crystalline structure is no more pronounced at the point of fracture than it would be at other points in the bar which were not subjected to fatigue.

This is a matter of the greatest importance to the rock drilling interests, and it is to be hoped that something more definite and conclusive may be evolved from the discussion which should follow the above paper.

ATMOSPHERIC CONDITIONS—SMOKE, HAZE, FOG*

BY ALFRED H. THIESSEN.

Unless one studies and observes the phenomena of smoke, haze and fog very carefully he will oftentimes not distinguish one from the other. Haze is generally supposed to consist of minute dust particles suspended in the atmosphere. I say generally, because some have advanced the theory that haze consists of condensed water vapor on dust near the earth's surface, but as haze is very prevalent in autumn, when relative humidity is quite low, it does not seem probable that condensation can take place on such a large scale. Haze exists in the upper as well as in the lower layers of the atmosphere, but when in the upper layers it consists of minute ice particles, and resembles a cirrus cloud, or it is composed of dust from meteors or from volcanoes. The haze near the earth's surface is probably caused by the dust of the earth being blown about. Haze is prevalent in autumn; the drying leaves at that time probably add to the source of dust.

Smoke, as we all know, is the product of the chimneys. It is composed of the unburnt products of coal mixed with some gases, among which are water vapor, carbon dioxide and sulphur dioxide. Clouds and fogs are formed by exactly the same processes, the cloud being an elevated fog and the fog being a low cloud. When air becomes saturated with moisture, some of that moisture condenses and forms cloud or fog. We distinguish between light haze, smoke or fog. If smoke or fog obscures an object one thousand feet away, it is called dense. Otherwise it is light.

It is usually said that fog or cloud is formed when the air becomes saturated or supersaturated; but this is not the whole story. To carry the explanation further we usually go back to the basic work of John Aiken. This experimenter was led to a line of inquiry which is very interesting to the meteorologist. He noticed that water never froze unless it was cooled to 32 degrees *and in contact with some other ice particles.* Also that water did not boil unless there was a free surface. If the heated water were covered with a layer of oil it may be far above 212 degrees without boiling. Reasoning from this it occurred to

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*Utah Society of Engineers.

him that steam would not condense unless there was a free surface on which to condense. The sides of the vessel containing the steam would act as a free surface, and steam condenses readily on them. The experiments showed that condensation in the form of cloud took place very readily when the air contained dust, but that no cloudy condensation took place when the air was filtered so as to be free from dust. Cloud is formed by the cooling which air undergoes when expanding. It is cooled below the dew point and condenses on minute solid particles. Fog is formed by the cooling of air below its dew point, but the cooling is brought about by radiation or by the transportation of air from a warmer to a colder region.

If no dust existed upon which the moisture could condense the condition would be very different from that which we know. The moisture would condense on all exposed objects. Trees, houses, and so forth would be dripping with moisture. Our clothes would soon become saturated and umbrellas would be useless. Even rain coats would not avail much as the moisture would condense on one's face and flow inside his collar. And this has actually been observed in cases where the air was practically free from dust and at the same time moist.

The records of the United States Weather Bureau office at Salt Lake City show a much greater per cent. of sunshine in summer than in winter. In summer it reaches as high as 83 per cent. in July and falls as low as 43 per cent. in December and January. Likewise cloudy and rainy days are more prevalent in winter than in summer, and humidity follows the same general characteristics, the greater *relative* humidity occurring in winter and the least in summer. A tabulation of the number of foggy and smoky days since the station was established shows that the greater number occur in November, December, January and February. A period from April to September, inclusive, is practically without fog or smoke as far as the records show.

Analyzing the records for the past twenty years we find an appreciable greater number of foggy days in the last decade. It seems, then, that with the growth of the city the foggy days have kept step with it. As smoke gives an abundant number of particles on which the water vapor in the atmosphere can condense, it is logical to assume that in any city the fogginess will increase as the consumption of coal increases. The condensation of water vapor also facilitates the radiation of heat at night and thus aids the formation of fog. The following table shows how fogs have increased with the size of the city of London.

Year.	Annual Number of Foggy Days.
1871—1875	50.8
1876—1880	58.4
1881—1885	62.2
1886—1890	74.2

The hazing effect of water vapor in the air is not due to simply its presence there, but its presence in the company with dust particles. Dust particles seem to have the property of making water vapor condense upon them even when the air is not saturated, but of course the effect is greater as saturation increases, and is proportional to the relative humidity.

The amount of dust and consequently the amount of fogs depend also upon the direction and velocity of the wind. It has been frequently observed that a strong northerly wind will clear the city of fog very quickly. But a wind of the same strength from the south will not have the same effect. This is because the southerly wind must work against gravity in blowing up against the benches, while a northerly wind works with gravity.

Fog is dissipated by the sun. This being so, one can see that a fog will last longer in a smoky atmosphere than in a clear atmosphere. That is, fogs, under the same condition in a city and country will be dissipated more quickly in the country than in the city. There is still another difference between country and city fogs. The country fog particle is made up very much the same as a cloudy particle which has a tendency to rain itself out of existence, but a city fog is persistent and has little tendency to fall.

In conclusion, then, it may be said that city fogs increase as the city increases. This is because of the greater amount of dust particles thrown into the air by combustion and other means, thus giving water vapor a surface upon which to condense. That fogs persist in a city more than in the country is due to their formation, and to the presence of smoke which does not allow the sun to evaporate them. The number of the cloudy days has a direct effect

not upon the number of fogs but upon their persisting after sunrise, allowing the fog to persist much longer than if it were exposed to the sun's rays.

NOTES

A fire-damp whistle has been invented in Germany, the principle upon which it works being that the tone of the whistle depends upon the density of the medium in which it is blown. The whistle is a metal cylinder, 10x2½ in. diameter, operated by an air compressor. An explosive condition in a mine is reached when the air is adulterated with about 5½ per cent. of firedamp, and demonstration to show whether this lighter-than-pure-air mixture will produce a whistle tone sufficiently different from normal to be detected by the ear is awaited with interest.

In Norway 12 years ago there was practically no production of electricity worth mentioning, but the horsepower now generated or being developed is approaching half a million. The practice has been to harness existing waterfalls or to dam natural lakes. Johan Haare, of Trondhjem, has worked out a completely new project which consists in the construction of an artificial lake as a reservoir for a small river, the Surna, in Nordmöre. The course of the river is to be altered by leading the water through a tunnel in a mountain a distance of two miles, thus obtaining a considerable fall. About 50,000 hp. will be made available.

By asking Congress to provide better for the Bureau of Mines, and even to enlarge its scope, President Wilson shows, in his message, that he realizes the true importance of mining in the general prosperity of these United States.

The superiority of American mining machinery is becoming generally recognized throughout the republic of Chile. This fact is indicated by the increased importations from the United States and the falling off of shipments from Germany and England. During the past 3 months, orders have been placed for larger amounts of machinery than ever in the history of the industry in the country. It is estimated that fully 85 per cent. of these orders went to the United States.

Some of the steam whalers that carry on the whale fishery off Tierra del Fuego are equipped with steam-driven compressors, and when a whale is killed and the tow line attached, a hollow lance tube with a hose attached is thrust through the blubber and the air compressor started. This inflates the carcass of the whale and facilitates towing it to the station where the try works are situated.

The Lake Champlain division of the N. Y. State Barge Canal is rapidly nearing completion, thirty-two miles being finished and twenty-three miles requiring some dredging. When the new dam at Troy is completed the new work will be navigable for 1,000 ton barges.

In using alcohol for a nonfreezing solution, it is found that when mixed with water, a mixture of 20 per cent. alcohol will not freeze above 10 deg. F., 30 deg. above zero F., 35 per cent. above 10 below zero, 40 per cent. above 20 below zero, and 50 per cent. above 35 below zero. The alcohol best fitted is not wood alcohol, but what is known to the trade as pyro alcohol, which is the ordinary alcohol, rendered unfit for drinking.

Two German chemists, after a series of experiments, have come to the conclusion that one coat of paint is a better protection for iron work than two or three coats, because the single coat is more elastic and less liable to crack or peel off. We are not told what paint was used.

To use ethyl alcohol as a carbon remover in automobile and other internal combustion engines, for which service it has been proved to be of great service, the best practice is to pour a half to a full wineglassful into each cylinder at night on shutting down, and let it remain until morning. To start up the engine, open the throttle wide and blow out the loosened carbon, which will have been made soft and flaky by the action of the alcohol.

Metal-shaving dies operate badly on some materials, drill rod, for example; when pressure is applied steadily, the metal is torn and left rough, but when the impelling force is applied as a series of blows, smooth cutting action results. Hence, the use of the pneu-

matic hammer to perform a shaving operation on drill rod that was found to be impossible when the power was applied by a press. —*Machinery.*

No other feat in the history of the oil industry has equalled the killing of the wild gas well near Oil City, La., that has been wasting from 10,000,000 to 20,000,000 cu. ft. of gas a day for the last 6 years. This great loss was stopped by the boring of a relief well close to the old well. When this well reached the same depth water and then mud was forced into the relief well under heavy air pressure. This soon chocked the gas stratum and shut off the flow. The work was done under the direction of the Louisiana state conservation commission which furnished a portion of the funds for the work. The remainder was furnished by gas and oil companies operating in Caddo parish. As soon as the flow of gas had been stopped, the well was cemented. The well had made a crater 225 ft. in diameter and 50 ft. deep.

The first time it was that I did ever make the ascent in the balloon took happening at Paris, and oh, I do wish never again it is to rise so high in the world. Up, up, up, we went until it did cross my mind that it must be to the heaven we were steering, and then, of the sudden, I did think of what would happen if the balloon it did go, as you say it "pop." And my heart it did thump, thump, thump, like the man who beats the carpet, and I felt it to be sure that I would never come down to the earth with a safe limb. But there is an end to all the things and enfin, at last, the balloon did get to the earth, and my anxiety it was over for the good and all.—*Gaby Deslys.*

A small electric fan just on the market has, attached to the motor, a concealed atomizer which adds perfume to the air current, and at once spreads it through the apartment.

A mixture of oil-gas and air begins to be explosive when the proportions are: gas, 7; air, 93. It is most explosive when the proportions are: gas, 15.4; air, 84.6; and the mixture begins to burn without explosion when the proportion is: gas, 24.5; air, 75.5.

A drawing had been made with the dimensions 12", but when sent into the shop the dimensions had mysteriously changed to 1.2". Investigation showed that a fly was repsonsible for the decimal point.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

NOVEMBER 4.

1,077,286. MEANS FOR STOPPING TRAINS. WILLIAM T. B. McDONALD, Granby, Quebec, Canada.

1,077,309. METHOD OF PREPARING ALUMINUM SULFATE. HEINRICH F. D. SCHWAHN, Belleville, Ill.

3. The method of preparing aluminum sulfate, which consists in treating sufficiently wet aluminous materials with sulfurous anhydrid and *ozone or ozonized air,* thus transforming the aluminum content of those materials into a sulfate and the iron content of such materials into a basic ferric salt, then lixiviating the resultant mass with water, and then separating the dissolved aluminum sulfate, the basic ferric salt with other insoluble ingredients contained in the aluminous materials remaining as a residue, thus producing a pure aluminum sulfate.

1,077,472. PNEUMATIC SPRING. JOSEF HOFMANN, Baumaroche, Switzerland.

1,077,509. WAVE-MOTOR. RICHARD A. BEMIS, San Bernardino, Cal.

1,077,521. APPARATUS FOR MEASURING THE VELOCITY AND INCLINATION OF THE WIND. HANS GERDIEN, Halensee, near Berlin, and RAGNAR HOLM, Charlottenburg, Germany.

1,077,584. VALVE-MOTION FOR ROCK-DRILLS. LEWIS C. BAYLES, Johannesburg, Transvaal.

1,077,697. VALVE FOR CONTROLLING COMPRESSED AIR. ALBERT J. GATES, Chicago, Ill.

1,077,724. ENGINE. JOHN D. KNEEDLER, Sioux City, Iowa.

1. In a combined compressor and motor, the combination of a casing having an inlet and outlet adapted to communicate with a storage tank through said inlet and outlet, said casing being also provided with an exhaust outlet, a rotor in the casing, a check valve in the first said outlet, a suction inlet communicating with the first said inlet, a three-way valve at the junction of the first said inlet and the suction inlet, a valve for controlling the exhaust outlet, and means for simultaneously actuating the last said valve and said three-way valve, so as to transform the combination into a motor or a compressor alternately.

1,077,803. OIL-FORGE FOR DRILL-STEEL. WILLIS W. CASE, JR., Denver, Colo.

1,077,856. PNEUMATIC FEED AND RETURN ROCK-DRILL. EBENEZER R. RAY, Placerville, Cal.

1,077,887. LOCOMOTIVE-GRATE SHAKER. FREDERICK W. MARTIN, New York, N. Y.

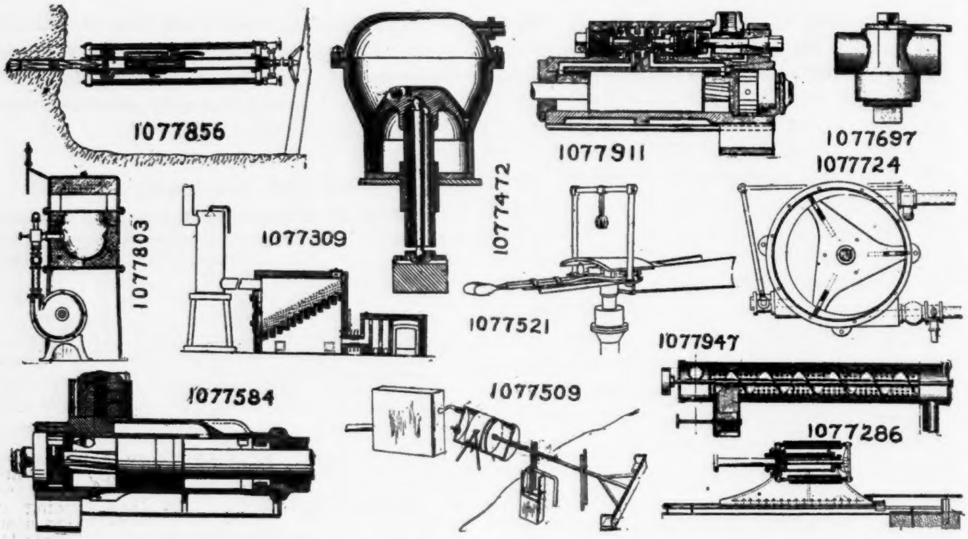
1,077,911. ROCK-DRILL. CHARLES A. HULTQUIST, Los Angeles, Cal.

1,077,947. VACUUM-CLEANER. ERLE L. ABRAMES and JOE H. CORYELL, Hayward, Okla.

NOVEMBER 11.

1,077,997. AIR LIFT-PUMP. THEODORE PETERS, Ferdinand, Ind.

4. An air lift pump comprising in combination, a pair of water cylinders communicating with a source of supply of water, each cylinder having an air pressure intake and an exhaust, rocking levers mounted upon a single pivot and one lever being provided with means for control-



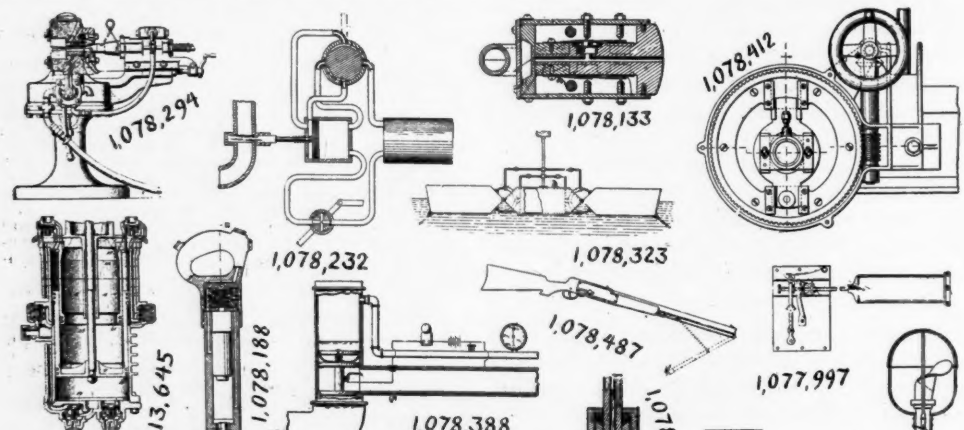
PNEUMATIC PATE NTS NOVEMBER 4.

ling the air intakes and the other lever being provided with means for controlling the air exhausts, and a float in one cylinder for rocking said levers to alternately close air exhausts and intakes of said cylinder, substantially as described.

1,078,028. LIQUID - DISPENSING DEVICE. HAROLD ROSCOE ZEAMANS, New York, N. Y.

1,078,074. MOTOR. JAMES VINSON, Tunnel Hill, Ill.

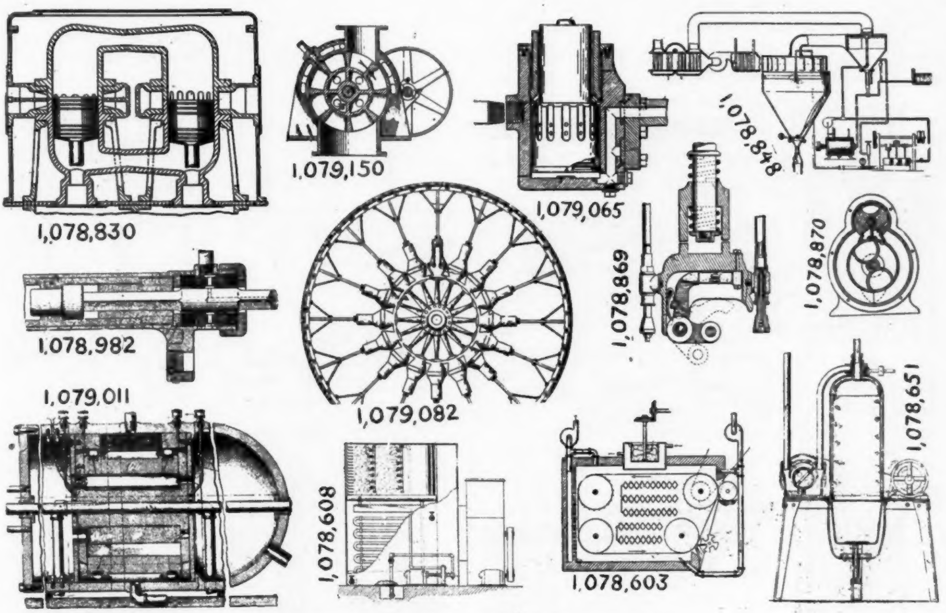
The combination with an air receiving casing, an upwardly extending air shaft, a flue connecting the casing with the lower portion of the shaft, a rotor within the flue, of arms fixedly connected to the air shaft and extending upwardly therefrom, an imperforate semi-spherical dome-like shield supported by the arms and over the air shaft, a hood mounted for rotation upon the upper end of the air shaft and below the shield, and a vane carried by the hood and located under and projecting into the semi-spherical shield and in the path of a direct current of air passing between the air shaft and the shield, to hold the outlet of the hood out of the wind, said shield constituting means for creating a whirling action of a portion of the air current passing under the shield.



PNEUMATIC PATENTS NOVEMBER 11.

1,078,133. PNEUMATO-ELECTRIC TRACKER-BAR FOR MUSICAL INSTRUMENTS. CHARLES W. DORRICOTT, Philadelphia, Pa.
1,078,185. VACUUM CLEANING DEVICE. ALFRED BEST, Salt Lake City, Utah.
1,078,188. PERCUSSIVE TOOL. WILLIAM CLEMENT, Phillipsburg, N. J.
1,078,232. SUPPLEMENTAL CONTROL FOR MOTIVE POWER. CHARLES A. WILLARD, Madison, Conn.
1,078,294. DRILL-SHARPENING MACHINE. JOHN GEORGE LEYNER, Denver, Colo.
1,078,295. DIE FOR DRILL-MAKING MACHINES. JOHN GEORGE LEYNER, Denver, Colo.
1,078,303. TRIPLE VALVE FOR AIR-BRAKES. SPENCER G. NEAL, Los Angeles, Cal.
1,078,323. WAVE-MOTION MOTOR. LYMAN A. TRULL, Manchester, N. H.

receptacle, an air tight receptacle, lined with copper, copper baffle plates mounted in the air tight receptacle, a body of copper supported in the receptacle, a pipe communicating with the boiler and the receptacle, a valve in the pipe, a steam inlet pipe communicating with the aforesaid pipe, a valve in the steam pipe, a furnace, a pipe communicating with the furnace and the receptacle and a valve in the latter pipe.
1,078,487. AIR-GUN. ARTHUR V. DICKEY, Seattle, Wash.
1,078,512. PNEUMATIC AGITATOR AND CLEANER. ALBERT W. MILLS, West Orange, N. J.
1,078,542. VACUUM-DREDGER. LAWRENCE B. GRAY, Boston, Mass.
1,078,595. PNEUMATIC GOVERNOR. BURTON S. AIKMAN, Chicago, Ill.



PNEUMATIC PATENTS NOVEMBER 18.

1. A wave motor, comprising a floating tank, a float movably connected therewith, and oppositely-acting fluid compressors arranged between and operatively connected to the float and tank.
1,078,329. PUMP FOR VACUUM-CLEANERS. IRVING BARKER, Springfield, Ill.
1,078,388. AUTOMATIC FIRE-EXTINGUISHING APPARATUS. LANSING VAN AUKEN, Watervliet, N. Y.
1. In an automatic fire extinguishing apparatus, water distributing pipes, an air chamber, air supply pipes, a valve in said air chamber controlling the supply of water to the water distributing pipes, an expansible member and an expanding member therefor on said valve and means normally forcing them apart, substantially as described.
1,078,384. PNEUMATIC HAMMER. GEORGE LAWSON ROBERTSON, Philadelphia, Pa.
1,078,397. PNEUMATIC CLEANING-MACHINE. MORRIS S. WRIGHT, Worcester, Mass.
1,078,412. BLOWPIPE APPARATUS. WORTHY C. BUCKNAM, Jersey City, N. J.
1,078,423. APPARATUS FOR OBTAINING NITROGEN FROM THE ATMOSPHERE. OTTO FRANK and OSKAR FINCKE, Berlin, Germany.
1. An apparatus for obtaining nitrogen from the atmosphere, comprising a compressed air

1,078,598. PNEUMATIC MOTOR. THOMAS A. DELANEY, Chicago, Ill.
13,645 (Reissue). AIR-COMPRESSOR. LOUIS G. STONE, London, England.

NOVEMBER 18.

1,078,603. MACHINERY FOR DRYING MILK AND SIMILAR FOOD. JENS OLE ANTONIO AMUNDSEN, Stavanger, Norway.
1,078,608. AIR-COOLING APPARATUS. WILLUS H. CARRIER, Buffalo, N. Y.
1,078,651. VACUUM CLEANING APPARATUS. THOMAS J. WINANS and DANIEL M. WINANS, Binghamton, N. Y.
1,078,661. FLUID-PRESSURE ENGINE. ALAN ERNEST LEOFRIC CHORLTON, Manchester, England.
1. In a valveless fluid pressure engine, two cylinders placed side by side, open communicating passages between both ends of the cylinders, inlet ports midway of one cylinder, exhaust ports midway of the second cylinder and a double acting piston in each cylinder, one of the said pistons being given a lead with respect to the other.
1,078,688. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. CALISTO J. MONFREDINI, Boston, Mass.

1,078,830. FLUID-PRESSURE ENGINE. ALAN ERNEST LEOFRIC CHORLTON, Manchester, England.

1,078,848. APPARATUS FOR DESICCATING LIQUIDS. CHESTER E. GRAY, Eureka, and AAGE JENSEN, Oakland, Cal.

1. An apparatus for recovering the constituent solids of liquids, embodying a desiccating chamber having a converging bottom with a discharge therein for desiccated material, means for introducing heated air tangentially into said chamber and withdrawing the same centrally, whereby cyclonic currents are set up in the chamber, and means for atomizing the liquid into the chamber at a point remote from its side walls and in proximity to the air exit.

1,078,869. ANTOMATIC AIR-VALVE CAR-COUPLING. GEORGE E. MUTH, Mansfield, Ohio.

1,078,870. DEVICE FOR PUMPING AIR OR OTHER FLUID. GUSTAF W. NYQUIST, Minneapolis, Minn.

1,078,952-3. HAMMER - DRILL. WILLIAM PRELLWITZ, Easton, Pa.

1,079,378. SUCTION-CLEANER. JOSEPH H. TEMPLIN, Philadelphia, Pa.

1,079,398. VACUUM SEPARATING - TRAP. WILLIAM F. COAKLEY and JOSIAH S. LEVENE, Kansas City, Mo.

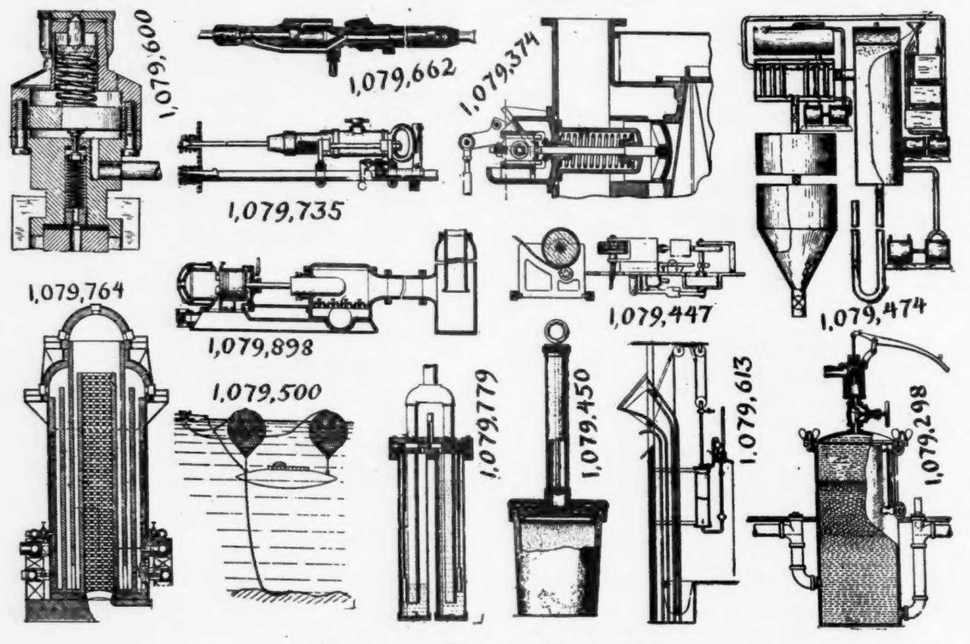
1,079,447. PNEUMATIC PRINTING MECHANISM FOR TYPE-WRITERS. MAX SOBLIK, Dresden-Klotzsche, Germany.

1,079,450. VACUUM-PACKAGE AND MEANS FOR SEALING SAME. GRAY STAUNTON, Muskegon, Mich.

1,079,474. PROCESS OF MAKING COFFEE EXTRACT. JOHN T. DAVIS, San Francisco, Cal.

1. The method of preparing coffee extract which consists in infusing roasted pulverized coffee berries with hot water at a temperature of 165° F., and then evaporating the water therefrom by the application of heat at a temperature of 165° F. to the mixture *at less than atmospheric pressure.*

1,079,500. APPARATUS FOR RAISING SUBMERGED BODIES. GEORGES LESOURD, Paris, France.



PNEUMATIC PATENTS NOVEMBER 25.

1,079,011. GAS GENERATOR AND COMPRESSOR. FREDERICK D. J. KAESSMANN, Coffeyville, Kans.

1,079,065. PIPE-PEENING MACHINE. JOHN I. PILSTON, Wyandotte, Mich.

5. A pneumatic tool, having in combination, hammer operating mechanism, a swiveling pipe line connected therewith for furnishing the operating medium, the said pipe line being connectible with the hammer-operating mechanism at more than one point for the purpose of giving said hammer varying radii of action, substantially as described.

1,079,082. PNEUMATIC VEHICLE-WHEEL. JOSEPH U. WELLS, Fallen Leaf, Cal.

1,079,150. VACUUM-VALVE. OLIVER S. SLEEPER, Buffalo, N. Y.

1,079,311. PNEUMATIC-DESPATCH APPARATUS. THOMAS BEMIS, Indianapolis, Ind.

NOVEMBER 25.

1,079,374. DISCHARGE-VALVE GEAR FOR BLOWING-ENGINES. CARL G. SPRADO, Milwaukee, Wis.

1,079,547. DRYING PLANT. GIOVANNI FALCHI, Marseille, France.

1,079,600. FLUID-PRESSURE-REGULATING GAGE. GUY L. KENNEDY, San Francisco, Cal.

1,079,613. AUTOMATIC - RETURN FLUID-OPERATED DEVICE. GEORGE F. STEEDMAN, St. Louis, Mo.

1,079,662. FLUID - PRESSURE - OPERATED TOOL. CAID H. PECK, Athens, Pa.

1,079,735. PNEUMATIC ROCK-DRILL. EDUARD ALTENHOFF, Oberhausen, Germany.

1,079,764. AIR-BLAST HEATER. EDMUND HOHMANN, Stettin, Germany.

1,079,779. PUMPING APPARATUS. PEARL A. LITTLE, Frederick, Okla.

1,079,898. APPARATUS FOR PUMPING LIQUIDS. THOMAS M. CHANCE, Philadelphia, Pa.

1,079,908. AIR-GUN. ADOLPH WISSLER, St. Louis, Mo.